ABSTRACT

Title of Document:	THE SALIENT MAP ANALYSIS FOR RESEARCH AND TEACHING (SMART) METHOD: POWERFUL POTENTIAL AS A FORMATIVE ASSESSMENT IN THE BIOMEDICAL SCIENCES.
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This dissertation consists of two studies: 1) development and characterization of the Salient Map Analysis for Research and Teaching (SMART) method as a formative assessment tool and 2) a case study exploring how a paramedic instructor's beliefs about learners affect her utilization of the SMART method and vice versa.

The first study explored: How can a novel concept map analysis method be designed as an effective formative assessment tool? The SMART method improves upon existing concept map analysis methods because it does not require hierarchically structured concept maps and it preserves the rich content of the maps instead of reducing each map down to a numerical score. The SMART method is performed by comparing a set of students' maps to each other and to an instructor's map. The resulting composite map depicts, in percentages and highlighted colors, the similarities and differences between all of the maps. Some advantages of the SMART

method as a formative assessment tool include its ability to highlight changes across time, problematic or alternative conceptions, and patterns of student responses at a glance.

Study two explored: How do a paramedic instructor's beliefs about students and learning affect – and become affected by – her use of the SMART method as a formative assessment tool? This case study of Angel, an expert paramedic instructor, begins to address a gap in the emergency medical services (EMS) education literature, which contains almost no research on teachers or pedagogy. Angel and I worked together as participant co-researchers (Heron & Reason, 1997) exploring the affordances of the SMART method. This study, based on those interactions with Angel, involved using open coding to identify themes (Strauss & Corbin, 1998) from Angel's views of students and use of the SMART method. Angel views learning as a sense-making process. She has a multi-faceted view of her students as novices and invests substantial time trying to understand their concept maps. Not only do these beliefs affect her use of the SMART method; in addition, her beliefs are refined through the use of the SMART method.

THE SALIENT MAP ANALYSIS FOR RESEARCH AND TEACHING (SMART)
METHOD: POWERFUL POTENTIAL AS A FORMATIVE ASSESSMENT IN
THE BIOMEDICAL SCIENCES.

By

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2015

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Dedication

To the forces and laws of this universe that gift humans with the intellectual curiosity and stamina to pursue understanding.

Acknowledgements

Most importantly I am grateful for my unquenchable love of learning and my determination to pursue a higher education for sixteen consecutive years. And so happy to have finally emerged from my "shell" and made the long journey South, back to my roots.

A lot of people helped me along the way and I am forever thankful to each of them.

My parents, Jim and Celia Cathcart, for raising me to love learning, providing me with every possible advantage and opportunity, supporting me through the challenges, celebrating my successes, and happily editing every page of this dissertation!
My brother, Ben Cathcart, for supplying me with a steady stream of comic relief and reality checks, inspiring me to take care of myself, and forever reminding me in such subtle ways that I may have the PhD, but I'm not the smartest Cathcart.
My best friend and partner, Phil Clinard, for being such a patient 24 / 7 listener, so lovingly doing all of the cooking and cleaning in the final 3-year-stretch, and most importantly encouraging me through my deepest, darkest, imposter syndrome days.

Angel Burba, for selflessly giving of your time, energy, and expertise to participate in this research. It literally wouldn't have happened without you! Your willingness to say exactly what you are thinking and to think so reflectively was critical to the success of this research.

Dr. Andy Elby, my advisor, for your beyond all expectations support and encouragement throughout my studies, never-ending patience in acting as a counselor more frequently than an academic advisor, and mind-blowingly insightful analyses of my data.

To my committee, for the unique perspective each of you contributed to my research. Dr. Bill Higgins, for keeping it real and relevant to science professors, after all you truly were my favorite science professor. Dr. Joe Redish for forever challenging my theoretical perspectives and consistently prodding me to challenge the existing literature. Dr. Dan Levin for putting the idea in my head that I needed to study this for my dissertation and challenging me to defend against weaknesses in my logic. Dr. Gili Marbach-Ad for sticking with me through this project from the very beginning through the very end and making sure I held true to a sound methodology. Dr. Dan Stein for having my back and telling it to me straight for so many years.

Dr. Ken Frauwirth, for sharing your students' immunology concept maps with me and for seeking my help with analyzing them. This entire dissertation was made possible by your original intellectual curiosity and passion for helping students.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Perhaps I was destined to study concept mapping for my dissertation. I have always been the type of student to draw out complicated ideas to help me better understand them. I truly don't remember ever being formally taught how to draw a concept map, perhaps I eventually stumbled upon the idea in my schooling and thought "Oh there's already a name for what I do." My first formal encounter with learning about concept maps took place during an introduction to qualitative research course during the summer of 2006. The professor, Dr. Hanne Mawhinney, suggested I learn more about them as a tool to help me with the master's thesis research I was planning. My plan was to study comprehensive reasoning about infectious diseases and she thought concept maps might help me organize and visualize what I meant by comprehensive reasoning. Interestingly enough, I did not end up using concept maps to assist me in that research, but went on to study them for my doctoral dissertation.

During my first semester of my doctoral program, my work supervisor, Dr. Ann Smith, asked me if I would be interested in assisting a colleague of hers, Dr. Ken Frauwirth, make some sense out of a set of his students' concept maps. So in my second semester, I enrolled in an independent study with my advisor to explore the concept map literature and attempt to apply it to this set of immunology students' concept maps. What I found in the literature was both frustrating and surprising for several reasons: 1) A majority of the methods in the literature for analyzing concept maps revolved around scoring the maps; 2) many of the methods were not applicable to these particular immunology concept maps because they did not adhere to traditional concept mapping norms; and 3) the analysis methods I was able to apply

did not garner instructionally useful information. I will review this literature and outline this argument in Chapter 2: Literature Review for the SMART Method.

With the help of my advisor at the time, Dr. Mike Stieff, I developed a new method for analyzing concept maps, the SMART method (Salient Map Analysis for Research and Teaching). I will introduce the SMART method and the procedure for performing the technique in Chapter 3: An Introduction to the SMART Method. I will walk readers through a detailed example of performing the analysis on a set of maps.

Following the development of the SMART method, (which at the time, I referred to as "using knowledge space theory") I published it as a conference proceeding and presented it at multiple conferences. The new method was quite well received at these conferences. Surprisingly though, I still viewed this research as just a really productive independent study. I had no intention of continuing to explore the SMART method for my dissertation until one of my future committee members, Dr. Dan Levin, suggested it to me at one of the conferences. He said that my research on the SMART method had too much potential and was too promising to not continue it for my dissertation. So I took some time to reflect on where I wanted to direct my career and how I wanted to use my dissertation to help.

It was also right about this time in my doctoral studies that I had to make some big decisions about my future research path because my advisor, Dr. Stieff was leaving the University of Maryland and heading to the University of Illinois. Also at about that time in my life I was realizing that my goal of becoming a microbiology professor wasn't as easily feasible as I hoped and I was exploring the possibility of becoming an emergency medical services (EMS) educator. The possibility of

combining my decade long passion of volunteering in the emergency medical

services with my love of academia and science education was very enticing. While

exploring EMS education as a profession, I met Ms. Angel Burba, an experienced

EMS educator who became a close mentor of mine. Through our conversations, she

became acquainted with my research and I with her teaching. Soon it became obvious

that we embark on a study in which I teach her the SMART method and she utilize it

on the concept maps that her paramedic students complete. One year later, the project

had finally obtained Internal Review Board approval from her community college and

we could begin!

The organization of this dissertation has been broken into two main studies.

The first study focuses on characterizing the utility of the SMART method as a

formative assessment. The second study is a case study of Angel, a paramedic

instructor, utilizing the SMART method.

Study 1: Development and Characterization of SMART Method

The first study tells the story behind the development of the SMART method

and characterizes its utility as a formative assessment. The SMART method was

developed to fill a critical need for a concept map analysis tool that produced

instructionally actionable data. The existing concept map literature consisted

primarily of analysis methods that produced scores and was not applicable to all types

of concept maps. The background argument and grounding in the literature for why

the SMART method is needed is outlined in Chapter 2: Literature Review for

SMART Method.

I will introduce the SMART method and the procedure for performing the technique in Chapter 3: An Introduction to the SMART Method. I will walk readers through the process of performing the SMART analysis on an actual set of concept maps from one of the study populations. I will also describe the study populations that were used during the development and characterization of the SMART method: an immunology class and two paramedic cohorts. Topics discussed in Chapter 3 will cover the entire SMART method from what it is and how to apply it to how to make interpretation decisions and easy ways to organize and collect the data. The product of the SMART method is a composite map that depicts in colors and numbers the similarities and differences between the students' and their instructor's concept maps. At the conclusion of Chapter 3 the reader will be ready to perform their own SMART analysis and produce a composite map, which they will learn how to interpret in Chapter 4.

The research question for this first study is: How can a novel concept map analysis method be designed as an effective formative assessment tool? This question will be answered in Chapter 4: The SMART Method as a Formative Assessment. I will discuss the types of instructionally informative data that can be gleamed from the SMART method including color patterns, changes across time, and alternative or problematic conceptions. The color patterns of the composite maps are particularly unique and informative, giving instructors at-a-glance information about their class.

Study 2: Case Study of Paramedic Instructor Utilizing SMART Method

The second study is a case study of a paramedic instructor utilizing the SMART method to analyze her students' concept maps. The background for this

study, a brief overview of emergency medical services (EMS), a review of EMS education literature, and the methodology for this study are described in Chapter 5: Background and Methods for Case Study. Mostly I chose to study Ms. Angel Burba, a paramedic instructor, due to my personal interest in pursuing a career in EMS education. Additionally, I thought Angel's intense passion for EMS education and interest in educational research would make for a fascinating case study.

I will briefly review the EMS education literature and outline an argument in Chapter 5 calling for more pedagogical, classroom-based EMS education research instead of the more prevalent systems-level research. Also in Chapter 5, I will outline the methodology I used to study Angel, the paramedic instructor. This study is a single-subject case study in which Angel and I worked together as participant co-researchers (Heron and Reason, 1997) to design concept map assignments and analyze her students' resulting concept maps.

The research question for this study is: How do a paramedic instructor's beliefs about students and learning affect – and become affected by – her use of the SMART method as a formative assessment tool? This question will be answered in Chapter 6: Case Study of a Paramedic Instructor Utilizing the SMART Method. There I will show how Angel's preexisting constructivist beliefs about learning and learners synergistically enhanced the utility of the tool as a formative assessment. Also, I will show how Angel's repeated use of the SMART method refined her beliefs about students. I will highlight data showing how Angel holds a complex view of her students as novice learners. She also has a view that she is continually learning, even from her novice students, and therefore uses the SMART tool to its fullest

potential to deeply analyze and attempt to understand how her novice students are conceptualizing ideas.

I will also discuss some implications for EMS education that this case study highlighted. The first is that EMS curricula need to be revised to allow time to address weaknesses that are identified during formative assessments. The second is the idea that as a profession EMS educators need to encourage critical thinking more and stop attempting to translate the gray world of patient care into black and white rules for our students to learn. While I won't presume to argue that either of these implications are novel, the SMART method brought them to the forefront of Angel's mind. I argue that the SMART method's highlighting of these important themes in EMS education has important implications for helping EMS educators.

I expect the main points of this dissertation will contribute to two different bodies of scholarly literature: 1) concept map analysis and 2) EMS education. I argue that the SMART method in and of itself is a worthy contribution to the concept map analysis literature as I will demonstrate the power of the technique as a formative assessment tool. But the main contribution of this dissertation to the concept mapping literature is the argument that techniques like the SMART method are needed to parse instructionally useful information from students' concept maps.

Additionally, this dissertation contributes to the EMS education literature by highlighting the lack of pedagogical, classroom-based educational research and by beginning to show the EMS education community how such research can benefit the field. The case study of Angel using the SMART method demonstrates how the use of the tool can not only inform an instructor's beliefs about her students, but also how

her beliefs affected her use of the tool. In this particular case, Angel's constructivist beliefs synergistically enhanced the power of the tool as a formative assessment. EMS educational research overwhelmingly focuses on system-based questions, so it is helpful to highlight the power of pedagogical research to focus instructors' attention on important topics within the field. The two topics that Angel's attention focused on through this case study were: 1) the need for EMS curricula to allow time for instructors to review content students are struggling to understand and 2) the importance of nurturing critical thinking in EMS students instead of misleading them into seeing the world of patient care as black and white.

Chapter 2: Literature Review for the SMART Method

The Salient Map Analysis for Research and Teaching (SMART) is a novel tool for analyzing concept maps. Concept maps are graphic organizers that, when properly implemented, can double as a formative assessment. In this chapter, I will outline the variety of types of concept maps and propose an overarching definition to encompass the diversity of concept maps. Then I will argue that scoring concept maps for the purposes of assessment is instructionally non-informative. Next I will propose that the SMART tool is an answer to this problem because it provides the instructor with actionable information from concept mapping assignments.

Concept Map Definition

Concept maps are graphic organizers that help students depict the relationships between concepts (See Figure 1). Each concept in the map is further defined by the pattern of concepts to which it is connected. This pattern results in a map consisting of nodes (concepts), which are connected by descriptive lines. The concept labels are signs that represent an abstract idea, event, or concrete object. Each node (concept) linked by its descriptive line to another node (concept) forms a proposition. Grammatically incorrect propositions are acceptable as the task of assuring grammatically sound concept maps would be overwhelming in more complex maps. This all-encompassing definition of a concept map will be used throughout the dissertation unless otherwise stated. This definition was formulated to include the variety of concept maps I have encountered in the literature, some of which I describe in this chapter.
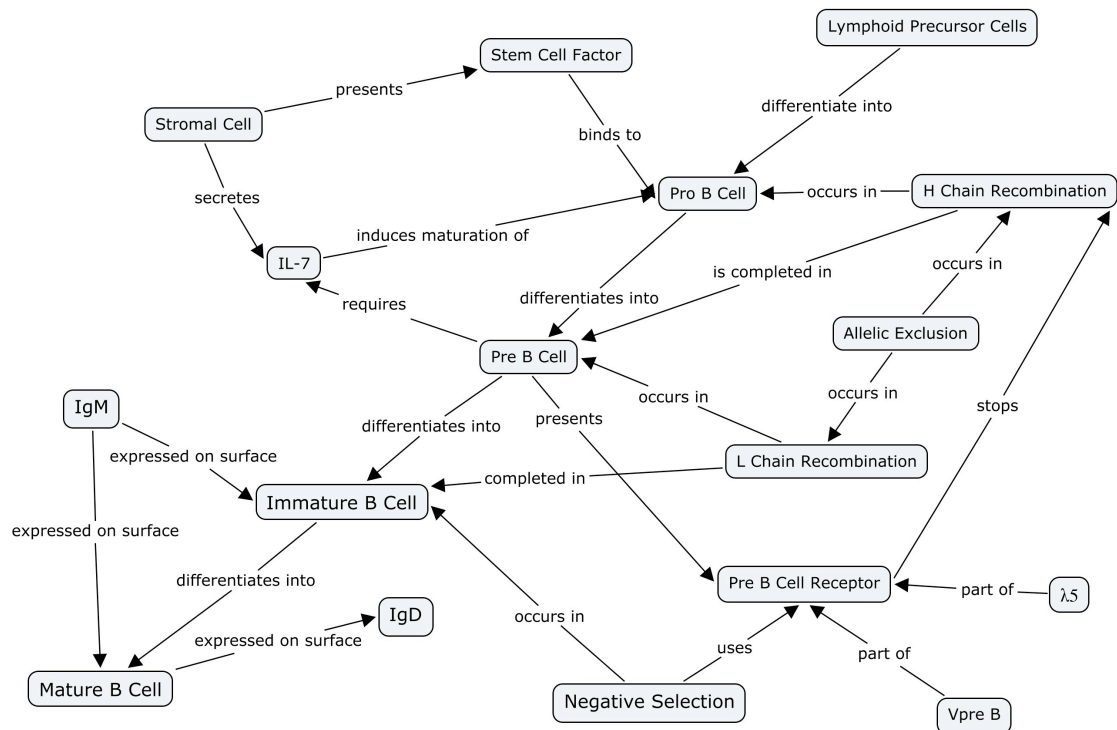
Figure 1. Example Concept Map of B Cell Development. This concept map was originally constructed by an immunology student. I redrew the concept map in Cmap Tools for demonstration purposes.

Theoretical Perspective on Concept Maps

It is possible to share the same technical definition of a concept map, but ascribe to a different theoretical perspective on what the concept map represents. I will outline one of the more common theoretical perspectives that I have encountered and clarify my theoretical perspective on concept maps. By far the most prevalent theoretical perspective assumes that a concept map represents a fixed, static representation of a knowledge structure in a student's mind. This perspective prevails in much of the concept mapping literature that I will review in this chapter and is representative of much of the concept mapping literature as a whole. This perspective corresponds roughly to a "classical cognitivist" perspective. A completely contrasting perspective views concept maps as a context dependent representation of what the

9

mapper felt was salient to include in their map at that moment in time. This perspective corresponds roughly to a "situated cognition" perspective. This perspective is the one I will prescribe to throughout this dissertation while discussing concept maps. I will discuss this in more detail at the beginning of Chapter 4.

Concept Map Development

Joseph Novak and his research group invented the concept map in 1972. They originally used concept maps to help uncover and visualize students' concepts and propositions from within large amounts of interview data. The researchers constructed concept maps to keep track of changes in students' concepts and propositions during the course of their schooling (Novak & Cañas, 2006). The graduate students who worked on this research project found concept maps helpful in their own learning. This led Novak to begin teaching a course titled, Learning to Learn, at Cornell University in 1975. Eventually this led to the publishing of Novak's 1984 book, Learning How to Learn, which he coauthored with D. Bob Gowin (Novak, 1990). As Novak's work on concept maps continued, he began working with the Florida Institute for Human and Machine Cognition (IHMC). IHMC publishes Cmap Tools, a free, multi-platform concept mapping program. Joseph Novak's impact on concept mapping research is profound. A Google Scholar search performed on the words "Joseph Novak concept map" returned 12,200 hits with approximately the first 70 citations authored or co-authored by Joseph Novak.

Types of Concept Maps

Concept maps can be categorized as either Novakian or non-Novakian depending on the steps the learner follows to construct the map. Novakian concept maps are constructed by strictly adhering to the steps outlined by Novak (1984, 2010) (See Table 1). Some criticisms of Novakian concept maps that I will discuss include: they are difficult to learn, learners may drift from the original focus question, and they require a forced hierarchical structure for the content. Non-Novakian concept maps fall into a more general category, as they do not follow as strict a set of rules for construction. Two specific types of non-Novakian concept maps that I will describe are the cyclical and hybrid cyclical concept maps. I argue that the definition of the hybrid cyclical concept map is the best way to describe the majority of the concept maps drawn by both the students and instructors in this dissertation.

Novakian

A Novakian concept map is "a schematic device for representing a set of

Table 1. Steps for Constructing a Novakian Concept Map. Excerpted from Novak & Gowin, 1984, p. 33-34 & Novak, 2010, p. 279-280.

1. "Identify a focus question that addresses the problem, issues, or knowledge domain."
2. Make a list of 10-20 concept words that are events or objects.
3. Rank order the list "by placing the broadest, most inclusive concept at the top" of the list.
4. Place the concepts on the map with the most inclusive concepts at the top following the ranked hierarchy.
5. "Connect the concepts with lines."
6. Label the lines with words that "define the relationship between the two concepts" to form valid propositions.
7. "Look for cross links" in different sections of the map and label them.
8. Identify specific examples of concepts and label them on the map.

concept meanings embedded in a framework of propositions" (Novak & Gowin, 1984, p. 15). The purpose of the Novakian concept map is to "represent meaningful relationships between concepts in the form of propositions" (Novak & Gowin, 1984, p. 15). Novak & Gowin (1984, p. 4) define a concept as "a regularity in events or objects designated by some label." By Novak's definition, events happen and objects exist (Novak & Gowin, 1984 & Novak, 2010). Novakian concept maps have a hierarchical structure so that broader, more general concepts appear at the top of the concept map and more specific concepts are positioned at the bottom of the map. Cross links are drawn between concepts in different branches or sections of the map (Novak & Gowin, 1984 & Novak, 2010). An example of a Novakian concept map is depicted in Figure 2.

Novakian concept maps are based on the psychological theories of Ausubel (1963). Ausubel proposed that if information is presented so that "clear, stable, and unambiguous meanings emerge" (Ausubel, 1963, p. 19) then meaningful learning could be achieved. In order for meaningful learning to occur, the content must also have meaning to the learner (Ausubel, 1963). Ausubel (1963) also theorized that the cognitive organization of knowledge is hierarchical in nature, thus the hierarchical structure of Novakian concept maps. "The model of cognitive organization proposed for the learning and retention of meaningful materials assumes the existence of a cognitive structure that is hierarchically organized…" (Ausubel, 1963, p. 24). A Novakian concept map is a tool for helping students to achieve Ausubel's meaningful learning. Next I will discuss some of the criticisms of Novakian concept maps, some of which are based on challenging Ausubel's underlying theory.
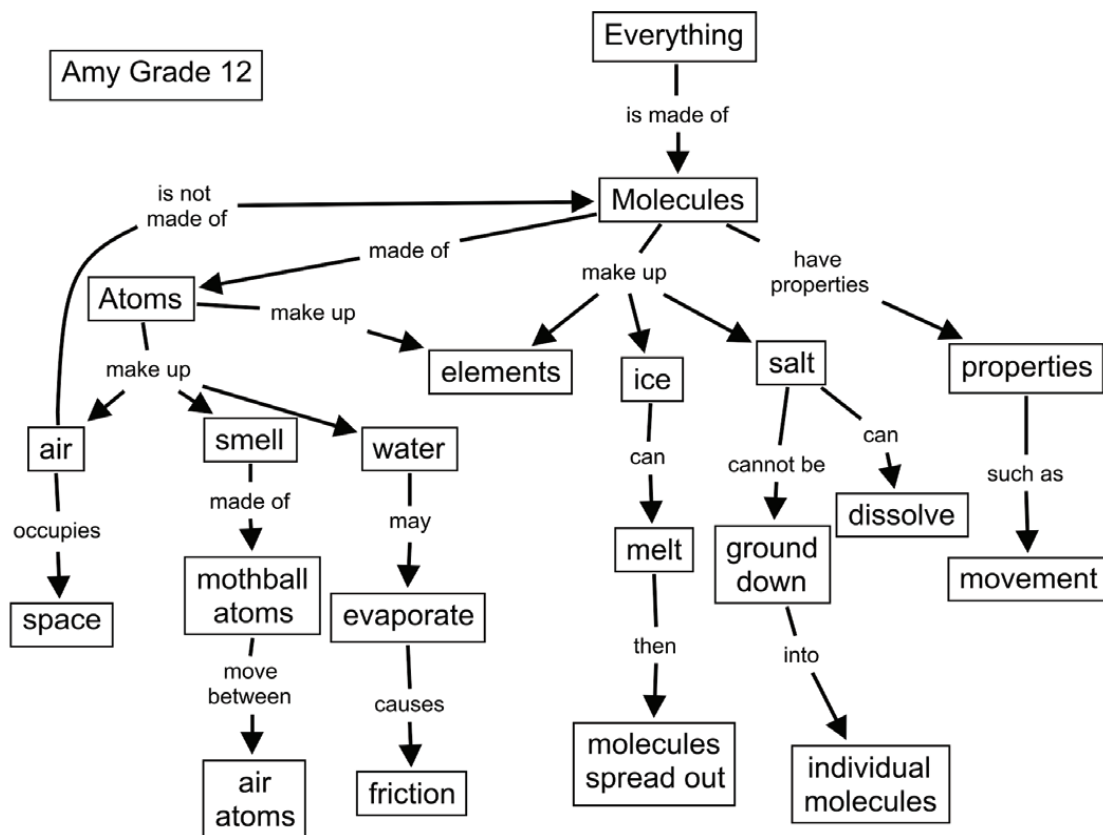
Figure 2. Example Novakian Concept Map. Excerpted from Novak & Cañas (2006). The concepts are enclosed in boxes. The propositions are the labeled arrows connecting the boxes (concepts). An example of a cross link is the proposition "Air is not made of molecules" linking the concepts, "Air" and "Molecules."

Criticisms of Novakian Concept Maps

Novakian concept maps have been criticized in the literature for a variety of different reasons. In this section, I will outline some of those criticisms, such as: 1) the rigid rules for constructing a Novakian concept map make it difficult to learn how to construct concept maps; 2) students tend to drift away from the focus question during concept map construction; and 3) Novakian concept maps force the content into a hierarchical structure.

Difficult to Learn How to Construct Concept Maps

One criticism of Novakian concept maps is that the rigid rules for constructing the concept maps make it difficult for students to learn how to construct the maps (Davies, 2011). The process of identifying the concepts and their relationships is challenging to students (Eppler, 2006). This theoretically is a challenge for any type of concept map, not just Novakian, as long as the mapper is expected to construct the map from scratch. Neither Davies nor Eppler elaborate any further on these claims and I could not find any empirical research on this problem. Cañas and Novak (2006) agree, "the construction and structure of propositions seems to be a problem that many concept mappers have" (Cañas & Novak, 2006, p. 1). Cañas and Novak (2006) propose that learners can be assisted in the construction of their concept maps by a focus question and by asking probing questions of each concept in the map.

Drift from Focus Question

Novakian concept maps are constructed to answer a specific focus question. Cañas and Novak (2006) identify a learner's failure to use a focus question as a common problem in the construction of concept maps. If a focus question is identified for the learner (often times it is not), they argue that learners tend to drift away from the focus question and instead answer a different focus question while constructing the map. Their proposed solutions to this problem are 1) to write a new focus question that matches the new map or 2) construct a new concept map that addresses the original focus question (Cañas & Novak, 2006). Neither of these solutions addresses the underlying root problem that students find it difficult to follow the originally posed focus question. This can become particularly problematic in a classroom setting

when a concept map is constructed to meet specific learning objectives. And perhaps part of the reason for the drift from the focus question in the first place is that students' are struggling to artificially fit content into a hierarchical structure.

Even more important to note is that perhaps the content a student includes in their concept map when they drift from the focus question should be of some interest to the instructor. The student is making a choice to include that content for a reason, and it tells a tale whether it is the one the instructor wants to hear or not. As I'll discuss in more detail later, one advantage to the SMART method is that it pays attention to all of the content students choose to include in their concept maps, whether on topic or not.

Forced Hierarchical Structure

The process of drawing a concept map is supposed to help students visualize connections between concepts they are learning. Sometimes learners naturally apply a hierarchical structure to the relationships between concepts, but there are a plethora of other possible structures. A concept map is already limited by its two-dimensional nature, so imposing a hierarchical structure on a concept map even further limits the learner's ability to represent the relationships between concepts on the map.

Imposing a hierarchical structure on the content is perhaps the biggest problem with Novakian concept maps. Some of the difficulty many students encounter while constructing Novakian concept maps might be attributed to the challenge of trying to 'fit' non-hierarchical ideas into a hierarchical format. Ruiz-Primo and Shavelson state, "…there is no need to impose a hierarchical structure. If the content structure is hierarchical, a hierarchical map should be observed" (Ruiz-

Primo & Shavelson, 1996, p. 578). And contrary to Ausebel's ideas about the hierarchical organization of knowledge, there is absolutely no reason to believe that there would be a hierarchical structure to the organization of ideas in the mind. In fact there is more reason to believe that knowledge isn't really structured in the mind at all but that individuals draw upon different distinct pieces of information to help them in a particular context at a given moment in time (diSessa, 1993).

While a hierarchical structure does sometimes apply to a topic and at times can be a productive organization tool, not all knowledge can be organized hierarchically. Steyvers and Tenenbaum (2005) discuss the efficiency of a hierarchical structure for categorizing knowledge but stress the limitations of such a structure on the types of knowledge that can be represented. Bertalanffy (1972) describes a model of open systems biology in which concepts mutually interact with each other to account for the gaps left by hierarchical order theories. Eppler (2006) notes how the hierarchical structure of concept maps does not accommodate sequential processes. Jonassen et al. (1997) state that the hierarchical structure of a concept map "significantly limits the reflection of personal understanding" (Jonassen et al., 1997, p. 299).

To summarize, Novakian concept maps are constructed with a strict set of guidelines designed to help the concept mapper achieve the meaningful learning described by Ausubel. Novakian concept maps are criticized for several reasons: 1) the level of difficulty they pose to new concept mappers, 2) requiring a focus question that may clash with the learner's needs, and 3) imposing a constraining hierarchical structure on the learner.

Non-Novakian

Many researchers and instructors use non-Novakian concept maps (see Figure 3) that do not strictly follow the Novakian rules (Austin & Shore, 1995; Brandt et al., 2001; Lay-Dopyera & Beyerbach, 1983; McClure et al., 1999; Nicoll, 2001; Ruiz-Primo et al., 2001; Schau et al., 2001; Walker & King, 2003; Williams, 1998). Most of these authors do not discuss the reasons for diverging from the Novakian guidelines, but it is possible that some of the previously described criticisms of Novakian concept maps played into their decisions.
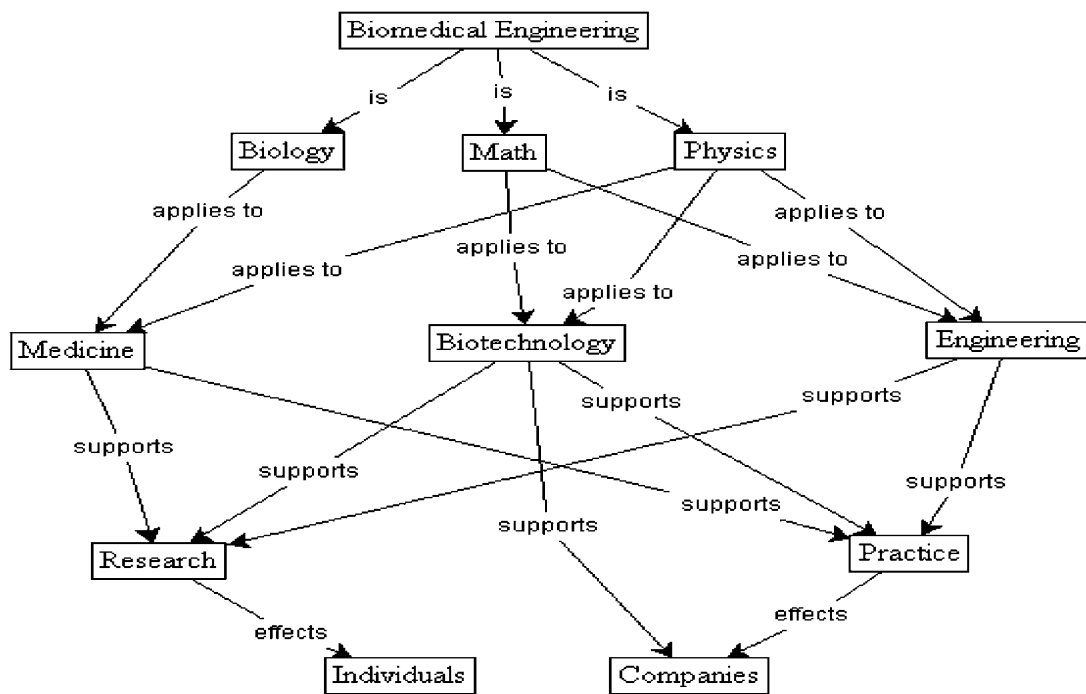
Figure 3. Non-Novakian Concept Map. Excerpted from Walker & King, 2003, p. 170.

nodes."[1] They describe a network concept map in contrast to the hierarchical Novakian concept map. The other nodes to which a concept is linked define each concept within a network concept map.

Amongst the great diversity of non-Novakian concept maps, there is one particular type that I am going to describe in more detail because it is uniquely suited for some scientific content. This type of map is called a cyclical concept map.

Cyclical Concept Maps

A specific type of concept map without a hierarchical structure is called a cyclical concept map. In a cyclical concept map, each concept has at least two propositions connecting it to the other concepts on the map, so that there are no "dead-end" concepts on the map. In a Novakian concept map, the hierarchical structure often leads to 'dead-end' branches where a concept is only connected to one other concept. Static propositions "describe, define, and organize knowledge" (Safayeni et al., 2005, p. 749) whereas dynamic propositions describe "how the change in one concept affects the other concept" (Safayeni et al., 2005, p. 750). An example of a concept map that would contain many static propositions is one that answers the question: "what is concept X?" (Derbentseva et al., 2007, p. 453). In order to answer the focus question, many of the propositions would define and describe concept X and related concepts. In contrast an example of a concept map that contains many dynamic propositions is one that answers the question: "how does

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[1] Ruiz-Primo & Shavelson's (1996) definition of a concept map is very similar to the definition of a concept map used in this paper; however, my definition also incorporates the semiotic nature of concepts as described by McAleese (1998). See Appendix A for a description of McAllese's (1998) definition.

the concept X work?" (Derbentseva et al., 2007, p.453). In order to answer the focus question, many of the propositions would need to describe how concepts affect each other or change (Derbentseva et al., 2007). I will discuss in more detail the difference between static and dynamic propositions in the next section. Safayeni et al. (2005) proposed that the structure of a concept map might influence the types of relationships, static or dynamic, which are included in the map.

Cyclical Concept Maps and Dynamic Thinking

One of the main advantages of cyclical concept maps is that when you remove the demands on the learner to artificially structure knowledge in a hierarchical way, they can now focus on making connections between ideas in a more meaningful manner. Safayeni et al. (2005) first proposed the idea that more static propositions appear in hierarchical concept maps and more dynamic propositions in cyclical concept maps. Next I will discuss research by Derbentseva et al. (2007) testing this very hypothesis.

Safayeni et al. (2005) hypothesized that the classic Novakian hierarchical structure supports the construction of concept maps with static propositions and that cyclical concept maps support the inclusion of dynamic concepts in a map. Derbentseva et al. (2007) tested this hypothesis by giving participants template concept maps to fill out. The word "plant," as in the living organism, was filled out in the top box of all the templates. One template was hierarchical without crosslinks, one was hierarchical with crosslinks, and one was completely cyclical. The propositions connecting the concepts in the templates were coded on a scale of 0, 0.5, and 1 for dynamic relationships. If the first concept enacted a change in the second

concept, then it received the full dynamic code of 1. An example of a proposition that receives a dynamic score of 1 is: "leaves release oxygen" (Derbentseva et al., 2007, p. 455). If the change was indirect or unclear, then the proposition received a 0.5 code. An example of a proposition that received a dynamic score of 0.5 is "number of plants is related to quality of soil" (Derbentseva et al., 2007, p. 455). Static propositions received a dynamic score of zero. A raw dynamic score was calculated for each map. The results of this experiment found that participants were statistically more likely to use dynamic propositions to fill out the cyclical template maps compared to both other templates (Derbentseva et al., 2007).

Safayeni et al. (2005) also hypothesized if the main "root" concept in the map were modified with a quantifier then the use of dynamic propositions would increase. A quantifier "draws attention to the specific property of a concept that can change" (Derbentseva et al., 2007, p. 452). One common example of a quantifier is one that refers to a quantity of a concept, but there are other dimensions along which a concept can vary such as quality or color for example. They predicted that the quantifier helped students think of 'what if' questions while constructing their maps. To test this second hypothesis, Derbentseva et al. (2007) gave students the same template maps; only this time the top concept box contained the words "as the number of plants increases." This data was analyzed using the same methods from the experiments used to test the first hypothesis. The results from this experiment showed that a quantifier on the root concept had a more powerful effect on dynamic thinking than the structure of the map (Derbentseva et al., 2007). Cañas and Novak (2006) note that while a dynamic focus question does promote the inclusion of more dynamic thinking

in a concept map, students still drift away from the question and the quantifiers on the concepts appear to have more of an effect. This claim appears to be anecdotal, as the authors do not discuss any data for this claim.

The third hypothesis that Derbentseva et al. (2007) tested was if a focus question asking for explanations, instead of descriptions, would trigger the inclusion of more dynamic propositions in the concept map. To test this hypothesis, they gave the participants a template with six interconnected boxes. The top box contained the word, "car." The participants answered one of two focus questions: "How does a car work?" or "What is a car?" This data was analyzed using the same methods from the experiments used to test the other two hypotheses. The 'How' question maps had significantly more dynamic propositions than the 'What' question maps.

In all three experiments, the researchers coded for quantifiers added to the concepts in the templates. However there were no significant differences in quantification of concepts on any of the maps for any of the experiments (Derbentseva et al., 2007). This means that the students did not restrict the possible dimensions of change for the concepts they included in their maps. One of the authors' theories about why concept quantification increases the inclusion of dynamic propositions is because it focuses the learner's attention on the potential for change in any given concept.

Based upon the research of Safayeni et al. (2005) and Derbentseva et al. (2007), cyclical concept maps support the construction of concept maps with dynamic propositions. Students included more dynamic propositions in their maps 1) if given cyclical template maps instead of hierarchical template maps; 2) when there was a

quantifier on the root concept in a template map; 3) when the focus question was dynamic (Derbentseva et al. 2007).

The research described above brings to light a great point about the potential diversity of content in students' concept maps. The student who choses to draw a concept map with propositions that represent causal relationships is engaged in thinking about those causal relationships during the construction of their map and potentially gains much more from the process. When Safayeni and Derbentseva assess student use of quantifiers and dynamic propositions in their concept maps, they are beginning to scratch the surface of a line of research examining these types of relationships students include in their concept maps.

Hybrid Cyclical Concept Maps

Safayeni et al. (2005) describe how it is possible to construct a stand-alone cyclical concept map containing all dynamic propositions, or a hybrid cyclical concept map (See Figure 4) containing both static and dynamic propositions[2]. Hybrid cyclical concept maps are particularly useful when drawing concept maps about scientific topics because they allow the learner to characterize both the static and dynamic aspects of scientific knowledge. To truly understand science, a learner must not only define and describe concepts, but also show how the concepts affect each other dynamically (Safayeni, et al., 2005). I argue that a majority of the concept maps that both students and instructors in my studies drew can be classified as hybrid cyclical concept maps.

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[2] There is an implicit assumption here that a "dead end" proposition is descriptive instead of causal. It is possible to think that there are exceptions to this assumption.

Up to this point, I have outlined some of the problems with strictly following the rules for constructing Novakian concept maps, and I have presented alternative non-Novakian concept maps to address some of these problems. In the next section, I will discuss the use of concept maps as assessment tools. I will argue that concept map scoring techniques do not produce instructionally useful information. And I will outline an argument calling for a more instructionally informative method of analyzing concept maps when using them as a formative assessment.
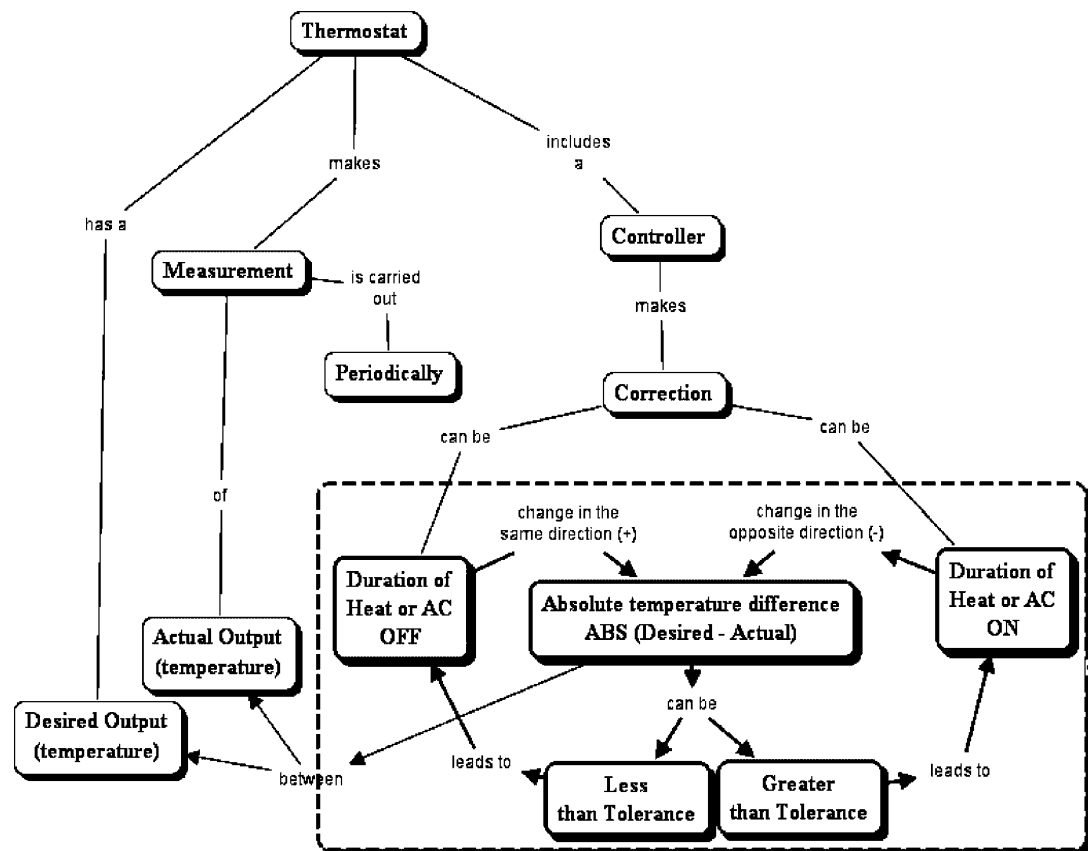
Figure 4. Hybrid Cyclical Concept Map excerpted from Safayeni et al., 2005. The static portions of the concept map appear outside of the dotted-line box. The dynamic portions and thus cyclical component of the hybrid concept map appear inside the dotted-line box.

Concept maps can be used as both formative and summative assessments. There are a wide variety of concept map assessments described in the literature (Ruiz-Primo & Shavelson, 1996). Traditionally, when used as an assessment, students' concept maps are scored. I will review the variety of assessments and scoring methods from the literature. Then I will pose an argument that a numerical score applied to a student's concept map is lacking the instructionally actionable information required to meet the needs of formative assessment.

Variety of Concept Map Assessments

In their 1996 review paper of concept map assessments, Ruiz-Primo and Shavelson describe three characteristics of concept map assessments. These characteristics are: 1) "a task that invites students to provide evidence bearing on their knowledge structure in a domain", 2) "a format for the student's response" and 3) "a scoring system by which students' concept maps can be evaluated accurately and consistently" (Ruiz-Primo & Shavelson, 1996, p. 573).

The authors proposed that the concept mapping task could vary based upon three criteria: a) demands, b) constraints, or c) content structures. Task demands are the overarching tasks assigned to the students when constructing their concept map (Ruiz-Primo & Shavelson, 1996). For instance, example task demands include: "fill in a skeleton map, construct a concept map…" (Ruiz-Primo & Shavelson, 1996, p. 758). The task constraints refer to the restrictions placed on the concept mapping task. Some restrictions may include requiring the construction of a hierarchical map, supplying the concept terms, supplying the labels for the linking lines, or constructing

the map as a collaborative group. Task content structures refer to the structure of knowledge in the concept map's subject or content area. Ideally the task demands and constraints should consider the content structures (Ruiz-Primo & Shavelson, 1996).

The authors proposed that the concept mapping response could vary based upon three criteria: a) "the response mode," b) "the characteristics of the response format," and c) "the mapper" (Ruiz-Primo & Shavelson, 1996, p. 759). The response mode can be hand drawn, orally communicated, or constructed with a computer program. The response format matches the task. So for example, if the task included a prescribed list of concept words, then the format would include that list of concepts. The mapper is the actual person who draws the map. This is usually the student, but is sometimes a teacher or a researcher (Ruiz-Primo & Shavelson, 1996).

Ruiz-Primo and Shavelson (1996) characterized the variety of concept map assessments based upon their task, format, and scoring method. The demands, constraints, and content structures characterize the task. The response mode, characteristics, and the mapper can characterize the format. As you can see there are quite a large variety of concept mapping assignments based upon the unique combination of task, format, and scoring method chosen. Next I will describe different concept map scoring methods.

Concept Map Scoring Methods

Concept map scoring methods can be divided into three types: 1) ones that "count the occurrence of features" (Roberts, 1999, p. 711), 2) ones that "compare the students' maps with a criterion map" (Ruiz-Primo & Shavelson, 1996, p. 852) or 3) a combination of both scoring methods (Ruiz-Primo & Shavelson, 1996 and Roberts,

1999). Examples of scoring methods that count the map's features include: Novak & Gowin's (1984) original scoring method (See Table 2) or adaptations of this method (Barenholz & Tamir, 1992 & Markham et al., 1994). One adaptation of Novak's method is the propositional/relational scoring method by McClure & Bell (1990) and McClure et al., (1999) (See Figure 5).

Table 2. Novak & Gowin's Scoring Criteria for Concept Maps. Excerpted from Novak & Gowin, 1984, p. 36.

Feature	Points	Criteria
Propositions	1	Score 1 point for each valid, meaningful proposition.
Hierarchy	5	Score 5 points for each valid hierarchical level.
Cross links	10	Score 10 points for each valid & significant cross link.
	2	Score 2 points for each valid cross link without synthesis.
Examples	1	Score 1 point for each specific event or object validly clarifying a concept.

The second concept map scoring method is to compare students' concept maps to a criterion map. Acton et al. (1994) found that the structure of expert's content knowledge varied widely. They found that using averaged expert knowledge structures as a criterion for evaluating students' knowledge structures was the best predictor of students' exam scores in a course. However, during the course of their study, the authors noted that occasionally some experts had knowledge structures that were exceptionally good at predicting students' exam scores and noted that further research into identifying these experts is warranted.

A combination of both the feature counting and criterion map comparison types of scoring methods can be used to score concept maps. Novak & Gowin (1984) describe how a student's map score can be divided by a criterion map score and multiplied by 100%. This allows for easy comparison of student maps.
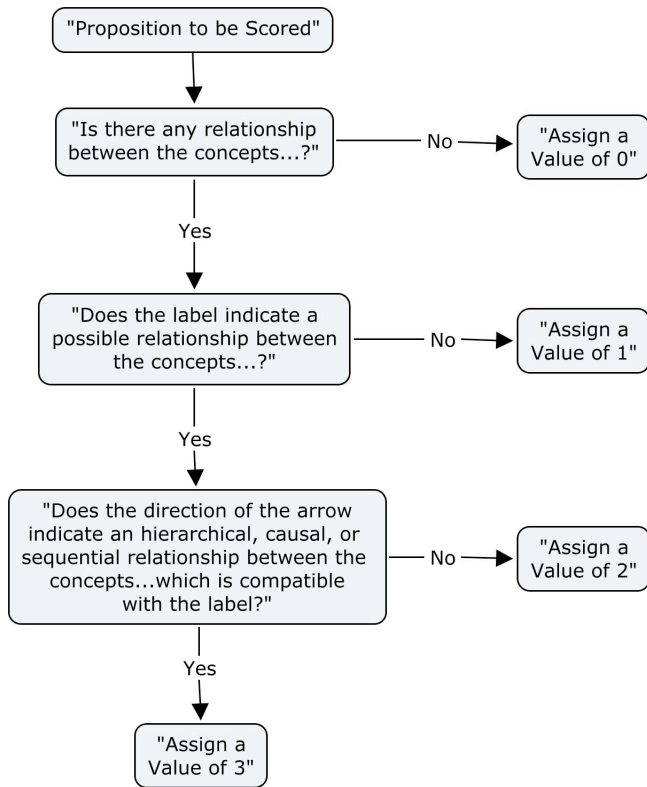
Figure 5. Propositional/Relational Scoring. Excerpted from McClure & Bell, 1990, Appendix D & McClure et al., 1999, p. 482.

Jonassen et al. (1997) propose that the scoring method for a concept map must be domain dependent and should emphasize the cognitive themes for that domain. The authors propose a list of possible scoring criteria to include in a concept map scoring method (See Table 3). Roberts (1999) tried to use multiple different concept map scoring methods from the literature to evaluate the concept maps of college level statistics

Table 3. List of Possible Scoring Criteria for Concept Maps. Excerpted from Jonassen et al. (1997), p. 301-302

1. "Number of Nodes"
2. Number of Propositions
3. Valid Propositions
4. Clear and Descriptive Propositions
5. Levels and Validity of Hierarchy
6. Causal versus Hierarchical Propositions
7. Number of Valid Crosslinks
8. Ratio of Links to Concepts
9. Centrality of Node (Number of Direct and Indirect Links)
10. Salience ("Number of Valid Links divided by Total Links")
11. "Consistency in use of links"
12. "Number of 'dead-end' nodes"
13. "Ratio of number of links to number of nodes"

students. When Roberts (1999) did not have any success with any of the existing scoring methods, she proposed that none were sufficient for the specific content depicted in statistical concept maps and created a new scoring method by combining aspects from the existing methods.

The variety of concept map scoring methods offers both researchers and instructors many options for designing a scoring method best suited to their task. However, scoring concept maps is sometimes a problematic task.

Criticisms of Scoring Concept Maps

When scoring a concept map, an instructor or researcher must ensure that the score accurately represents the student's understanding of the information depicted in the map. To assure this, concept map scoring methods need to be reliable and valid.

Assumptions Underlying Concept Map Scoring

Stuart (1985) outlines three assumptions that must be met in order to validate the use of a concept map scoring method. These assumptions are 1) concept maps represent student thinking, 2) concept maps can be scored to a degree sensitive enough to detect differences across time or between learners and 3) the concept maps component scores are independent (Stuart, 1985). For the purposes of this paper, I am going to focus on Stuart's second assumption.

I was able to identify two studies in the research literature addressing Stuart's second assumption. Lay-Dopyera and Beyerbach (1983) designed a study to look for differences in the concept map scores between students in an introductory undergraduate education course, an advanced undergraduate education course, and a

graduate education course. The concept maps in this study were scored using a component-based scoring method that counted the presence of map features. There were statistically significant differences between courses for only some of the students' concept map component scores. The study also looked for differences between individual students based upon a rank assigned by the course instructors. There were no statistically significant differences between individual students (Lay-Dopyera & Beyerbach, 1983).

Markham et al. (1994) also studied Stuart's second assumption by looking for differences between the concept map scores for advanced college biology majors and beginning college biology non-majors. Both groups of students were asked to draw concept maps about the same topic, mammals. The concept maps were scored, using Novak & Gowin's (1984) criteria. Statistically significant differences between the two groups were found for all of the component scores (Markham et al., 1994).

Lay-Dopyera & Beyerbach (1983) and Markham et al. (1994) demonstrate how concept map scoring methods vary in terms of their ability to differentiate students. This finding has implications for the validity of concept map scoring methods. While there is really very little research on this matter, what these two studies show is that the finer the grain you try to look for, the more unlikely concept map scoring is going to be able to show differences. Markham et al. (1994) were looking at a fairly large grain size for differences based upon concept map scoring, differences between advanced biology majors and beginning biology non-majors. Whereas Lay-Dopyera and Beyerbach (1983), in addition to looking at these larger grain sizes, tried to look at the individual student level and were not able to see any

differences. I argue that concept map scoring must then have a fairly wide margin of error and may not be the most productive way to analyze the maps.

Concept Map Score Reliability and Validity

In 1996, Ruiz-Primo and Shavelson, highlighted the lack of research into the reliability and validity of concept map scoring methods. In their review of the limited research on the topic, the authors critiqued the few studies for using oversimplified scoring criteria, small sample sizes, and discarding outliers (Ruiz-Primo and Shavelson, 1996). I am going to discuss some of the most cited studies about concept map score reliability and validity leading to Ruiz-Primo and Shavelson's (1996) article and following their review. The following discussion is by no means an exhaustive review of all of the literature on concept map scoring reliability or validity.

In 1983, a year before the publication of Novak and Gowin's (1984) foundational book on concept mapping, Novak et al. published the results from a study where the authors compared students' concept map scores to standardized test scores and final course grades. The researchers found that students' concept map scores were not correlated with either traditional assessment measure. Their conclusion was that concept maps assess a different type of knowledge than traditional assessments (Novak et al., 1983). While I do tend to agree that concept maps are a unique form of assessment placing very specific demands on students, the authors do touch on one interesting factor: motivation. They noticed that students from any ability level could score any possible score on a concept map. They attributed this to other factors such as motivation. In my experience working with

concept maps over the past seven years, I think the effect of motivation on a students’ concept map product cannot be overstated. Constructing a concept map is a thought intensive process and one must be highly motivated in order to produce a thorough map of a topic. For this reason it should be no surprise that concept map scores do not readily correlate to other traditional forms of assessment.

Liu & Hinchley (1996) examined the correlations between the component scores of concept maps using Novak & Gowin’s (1984) scoring method. The authors found that the number of statistically significant correlations between component scores varied for students with different amounts of experience with concept mapping. Liu and Hinchley (1996) concluded from this study that Novak’s scoring method was internally inconsistent and lacked internal validity. They argue that Novak et al. (1983) failed to find a correlation between concept map scores and traditional assessments measures because the concept map scoring method was internally invalid. While calling for concept map scoring methods that are more internally valid, they fail to suggest any ways in which to achieve this feat.

Since 1996, concept map researchers have responded to Ruiz-Primo and Shavelson’s criticism with more studies about the reliability and validity of concept map scoring. I will discuss some of the more frequently cited articles.

Rice et al. (1998) evaluated the validity of a novel concept map scoring method based off the course learning objectives in a seventh grade life sciences curriculum. The students took a multiple-choice test at the end of several units and also drew a concept map. The concepts given to the students to include in their concept maps matched the concepts tested by the multiple choice questions, and both

of these aligned to the course learning objectives. The authors devised a novel concept map scoring method that compared each multiple choice question to a student's map, based upon three criteria: 1) the presence of the multiple choice stem concepts on the map, 2) the relationship between the multiple choice stem concepts and the correct answer concept, and 3) the relationship between the multiple choice stem concepts and any distractor concepts. These novel concept map scores were highly correlated with the unit test scores, as well as state and national standardized tests (Rice et al., 1998). It should come as no surprise that these authors found high correlations between a multiple choice exam and concept map scores when scoring students concept maps using this scheme. They were scoring maps based upon presence of exam question components.

McClure et al. (1999) examined the reliability and validity of three different concept map scoring methods: holistic, relational, and structural, each with and without a master map. The holistic scoring method involves assigning the map a score on a 1 to 10 scale based upon the scorer's judgment that the map represents the "mapper's overall understanding of the concepts represented by the map" (McClure et al., 1999, p. 483). The relational scoring method is depicted in Figure 5. The structural scoring method awarded points for the presence of different features within the map, similar to Novak & Gowin's (1984) technique and the list of possible scoring criteria listed in Table 3.

McClure et al. (1999) calculated generalizability coefficients[3] for each of the scoring methods to estimate their reliability. The g-coefficients for the scoring

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[3] Generalizability Coefficient = $\sigma_s^2 / (\sigma_s^2 + \sigma_{sr}^2)$

methods varied from: 0.23 (structural with master map) to 0.76 (relational with master map). The authors' explain that the variance in generalizability coefficients is due to the different cognitive loads the scoring methods impose on the rater, with relational imposing the lowest load and structural the highest load (McClure, 1999).

For each student map, a map similarity score was calculated by comparing the student's map to the master map. To estimate the validity of the scoring methods, the Pearson product moment correlation (r) was calculated by comparing the map similarity scores to the map scores and the mean map score for each scoring method. The mean correlations between map scores and map similarities were statistically significant (**$p<0.01$) for each of the scoring methods except the structural method with a master map (McClure, 1999).

My main criticism of McClure et al. (1999) is the small sample size (63 concept maps) with just two raters for each type of scoring method. I am very curious if the results would have changed if a larger sample with more raters had been used. One important take away from this paper is the notion that a rater's cognitive load affects the reliability of a concept map score. McClure et al. (1999) propose that the relational scoring method with master map was the most reliable scoring method because it posed the least cognitive load by allowing the rater to consider each proposition individually.

As highlighted by Ruiz-Primo and Shavelson in their 1996 review article, research on concept map scoring method reliability and validity was lacking prior to 1996. Perhaps in response to this article, the amount of research focusing on concept

σ_s^2 = variance associated with individual students; σ_{sr}^2 = variance associated with the interaction between students and raters (McClure et al., 1999)

map scoring method reliability and validity increased post-1996. Still, in comparison to the numerous and ever expanding literature on different concept map scoring methods, the studies specifically addressing the reliability and validity of concept map scores are much fewer in number. Perhaps one of the most important ideas that can be learned from all of the research into concept map scoring method reliability and validity is that concept mapping, along with the raters' ability to score the map, is context dependent.

While reliable and valid concept map scoring methods would be useful for summative assessment, the information gathered from a numerical score is limited for the purposes of formative assessment. Instructors utilizing concept maps for formative assessment need more instructionally actionable information to make the next pedagogical decision in the classroom. In the next section of this paper, I am going to review the characteristics of formative assessment and argue that scoring a concept map is not productive for formative assessment.

Formative Assessment

I am proposing that concept maps be used as a formative assessment, but first I am going to focus on the definition and characteristics of formative assessment. Then I will explain how scoring a concept map, even if a valid and reliable method could be developed, does not conform at all to the tenets of formative assessment. A score does not reveal any specific "misconceptions" or productive ideas that students are including in their concept maps.

Definition of Formative Assessment

Black and Wiliam (1998) define formative assessment "as encompassing all those activities undertaken by teachers and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (Black & Wiliam, 1998, p. 7-8) The word formative means "with forming or molding something, usually to a desired end" (Sadler, 1989, p. 120).

In Sadler's (1989) theory of formative assessment, he outlines three simultaneous processes that occur during formative assessment. During these processes the learner has to 1) "possess a concept of the standard (or goal, or reference level) being aimed for," 2) "compare the actual (or current) level of performance with the standard" and, 3) "engage in appropriate action which leads to some closure of the gap" (Sadler, 1989, p. 121). When an outside source gathers information leading to the closure gap it is called feedback. Whereas when the student gathers information leading to the closure gap, it is called self-monitoring (Sadler, 1989).

I wish to draw the reader's attention to the feedback component of formative assessment, as I will propose later that concept maps analyzed by the Salient Map Analysis for Research and Teaching (SMART) method can be a valuable source of feedback for instructors. Next I will elaborate more on the characteristics of formative assessment.

Characteristics of Formative Assessment

There are many well-researched characteristics of formative assessment in the literature (Bell & Cowie, 2001). For the purposes of this paper, I am going to focus

on the characteristics relating to the teacher's ability to gather instructionally actionable information.

Formative assessment, by its nature, collects instructionally actionable data. Harlen and James (1997) describe how formative assessment is criterion-referenced as opposed to norm-referenced. Criterion-referenced assessments provide information upon which action can be taken. Norm-referenced assessments are capable of identifying problematic areas, but do not offer any suggestions about where to proceed next (Harlen & James, 1997).

Scoring a concept map is a form of norm-referenced assessment because it compares the quality of students' concept maps to each other. From a teacher's perspective, knowing that some students' concept maps scored relatively low, compared to other students in the class, provides little information about why these students' scored lower. In order to provide the low scoring students with helpful feedback on their concept maps, the teacher must use another form of data in addition to the concept map score.

One of the main purposes of formative assessment is to provide students with feedback (Boston, 2002). Sadler (1998) identifies three elements to a teacher giving feedback: 1) attending to the student's product, 2) comparing the student's product to a framework, and 3) providing the actual feedback to the student. Nicol and Macfarlane-Dick (2006) emphasize that teachers need access to helpful assessment data in order to provide valuable feedback to their students. It's helpful for the teachers themselves to review and reflect upon the assessment data (Nicol & Macfarlane-Dick, 2006). Next, I will argue that scoring a concept map overlooks the

wealth of information depicted in the concept map, limiting the usefulness of concept map scores.

Limits to Instructional Actionability of Concept Map Scores

For a concept map to be effectively used as a formative assessment, the wealth of information students depict in the map must be taken into consideration in a concept map analysis method. Often times in the process of generating a numerical score for a concept map, potentially valuable information about where to proceed instructionally is lost.

A numerical score assigned to a student's concept map can be unrevealing about the content displayed within the map. "A score, whether from a concept map test, standard objective test, or some other type of performance, reduces a complex task to a single number; and while these numbers may be useful in some cases, much information is lost" (McClure et al., 1999, p. 491). Kinchin et al. point out how "the aggregation of scoring of elements creates a blurring of what the overall score actually reveals" (Kinchin et al., 2000, p.46). The constructivist epistemology in which concept mapping is based places diagnostic value on both the valid and invalid links that a student may use to support their overall knowledge as their learning progresses. Many scoring techniques dismiss invalid links between concepts, thus overlooking the progress a student is making towards a more complete understanding of a topic (Kinchin et al., 2000 & Kinchin, 2001).

Assigning a numerical score to a concept map overlooks the complexity of the map and its potential usefulness as a formative assessment tool. Some researchers have proposed non-scoring methods for analyzing concept maps.

Scoring a concept map is only one possible way to analyze the concept maps drawn by students. Qualitative methods for analyzing concept maps have been proposed in contrast to scoring concept maps. While these qualitative methods are not limited to condensing the rich data of concept maps down to a single number score, I will argue that the existing methods still fall short of being instructionally useful.

The most promising qualitative analysis method, by Kinchin et al. (2000), proposed that the structure of concept maps could be qualitatively analyzed for complexity. In their method, maps are described as containing a spoke, chain, or net structure. The simplest maps have a spoke structure in which all of the concepts are directly connected to a main concept. In a map with a chain structure, all of the concepts are linked in a chain of linear causality. In the most complex maps the concepts are related in a net of complex relationships depicting appropriate hierarchy (Kinchin et al., 2000).

While this method does look at the complexity of the overall map drawn by the student, it fails to look at the content of the ideas depicted within the map. Two maps with the same level of complexity may actually depict very different depth of content. For instance, propositions may be static or dynamic; concepts may or may not be quantified. This method still falls short of providing instructionally useful information from concept maps used as a formative assessment.

Summary of Literature

Concept maps are an instructional tool with the potential to become a formative assessment when implemented appropriately. The hierarchical structure

associated with Novakian concept maps is problematic because it does not actually represent the way knowledge is structured and it causes students to struggle to depict their ideas in the confines of a hierarchical concept map. There are some other forms of concept maps that are better at eliciting students' ideas without unnecessary restraints, such as hybrid cyclical concept maps. Hybrid cyclical concept maps arguably allow students to express both causal and descriptive relationships about concepts within the same map without the restraints of a hierarchical structure.

Problems arise though when concept map scoring methods are used to analyze concept maps and boil the rich content of the map down to a single number. If a concept map scoring method were found to be reliable and valid, it would at best serve only as a summative assessment tool. Reducing the rich information in a concept map to a number fails to provide instructionally useful information about the map to the instructor and student. A concept map analysis method needs to meet the criteria for a formative assessment if it is expected to produce instructionally actionable information. Building on non-scoring concept map analysis methods, I will propose that the SMART method for concept map analysis meets this need.

Chapter 3: Introduction to the SMART Method

The Salient Map Analysis for Research and Teaching (SMART) method is a novel concept map analysis technique that compares a set of students' concept maps to a teacher's concept map. The product of the SMART analysis is a composite map depicting both the quantitative and qualitative similarities and differences between the students' concept maps and the teacher's concept map. Previously, I defined concept maps as graphic organizers that help students to depict relationships between concepts. Within a concept map there are nodes (concepts) connected by linking lines. The nodes represent concepts that are defined by the other concept nodes to which they are connected. The linking lines are labeled with phrases that form rough sentences when read as if sandwiched between the concept words at both ends. This combination of the concepts at either end of a linking line, and their connecting words, is called a proposition. When using the SMART method, most of the comparison of the concept maps lies in the similarities and differences between the propositions in the maps. In this chapter, I am going to: 1) describe how the SMART method was developed, 2) provide some background about the contexts in which I have studied the use of the SMART method, and 3) describe in detail how to use the SMART method to analyze a set of concept maps.

Development of the SMART Method

As I argued in Chapter 2, the SMART method was developed out of necessity. I learned of the need for a new concept map analysis method during my first year as a doctoral student. The SMART method is the product of the analysis of an entire

semester's worth of immunology students' concept maps. I analyzed these concept maps as part of an independent study assisting the course professor to make sense out of the large amount of data contained within his students' maps. I poured through the literature on concept map analysis methods and tried analyzing the immunology concept maps with many of the existing methods in the literature. Methods I tried included relational scoring (McClure et al., 1999) and qualitative structure analysis (Kinchin et al., 2000). Many analysis methods did not apply because the maps did not adhere to the traditional hierarchical structure as outlined by Novak (1984).

One of the most striking lessons I learned from trying many of the existing concept map analysis methods was that the resulting analysis products were fairly abstract. Teachers using concepts maps in their classrooms did not have an easy way to extract any actionable information from their students' concept maps. I was determined that it was possible to analyze the immunology concept maps in a manner that produced actionable data. Ultimately, I developed the SMART method loosely based on a mathematical theory known as knowledge space theory (Doignon & Falmagne, 1985 and Falmagne & Doignon, 1988).

Knowledge space theory stipulates that at any point in time, an entity, is either present or absent. When applied to concept maps, this idea is extended to look for the presence or absence of concepts and propositions. One of the biggest advantages of knowledge space theory is the potential to track changes across time. In these studies however, I was focused on determining if the theory could be successfully adapted to concept maps and on identifying the potential value of the resulting SMART method

to instructors. The SMART method's utility does not depend on knowledge space theory, but instead was inspired by the theory.

Study Populations

During the development of the SMART method, I studied the concept maps drawn by three different cohorts of students and their instructors. One cohort was enrolled in an upper level undergraduate immunology course at a university. The other two cohorts were enrolled in an accelerated paramedic program at a community college.

I analyzed 208 concept maps drawn by a class of 98 immunology students (See Table 4). The 10 concept map topics from the immunology class were: B Cell Development, Germinal Centers, Major Histocompatability Complex, T Cell Development, Costimulation, Cytokines, Autoimmunity / Tolerance, Alloreactivity / Immunosuppression, Vaccines, and Immune Responses to Tumors. The immunology students received 1% extra credit towards their final course grade for completing at least 5 concept maps. 37 students completed at least the 5 maps required for the extra credit and 89 students completed at least 1 map.

Both the first and second paramedic cohort had 12 students. I analyzed 21 concept maps drawn by the first paramedic cohort, about two different topics (See Table 4). I analyzed 33 concept maps drawn by the second paramedic cohort, about three different topics (See Table 4). The concept map topics from the first paramedic cohort were Autonomic Nervous System and Diabetes. The concept map topics from the second paramedic cohort were Autonomic Nervous System, Respiratory

Table 4. Number of Student Concept Maps per Lecture Topic by Student Cohort.

Immunology Course (n=98)		First Paramedic Cohort (n=12)	
Lecture Topics	**# Student Maps**	**Lecture Topics**	**# Student Maps**
B Cell Development	27	Autonomic Nervous System	12
Germinal Centers	25	Diabetes	9
Major Histocompatibility Complex	24	**Total**	21
T Cell Development	23	**Second Paramedic Cohort** (n=12)	
Costimulation	17	**Lecture Topics**	**# Student Maps**
Cytokines	18	Autonomic Nervous System	12
Autoimmunity/Tolerance	20	Respiratory Medicines	11
Alloreactivity/Immunosuppression	27	Shock	10
Vaccines	17	**Total**	33
Immune Responses to Tumors	10		
Total Immunology Course	208	**Total Both Paramedic Cohorts**	54

Medicines, and Shock. The same instructor taught both paramedic cohorts. The paramedic students completed the concept maps as part of their assigned coursework.

Concept Map Assignments

For all of the sets of concept maps analyzed in this paper, the course instructors developed the concept map assignments based upon course learning objectives. The instructors constructed an expected concept map about each topic based upon the learning objectives for the topic. This concept map was designed to predict the concepts and propositions the students would depict in their concept maps based upon their learning in the course. An alphabetical list of concept words was derived from each instructor's expected concept map. The immunology students were given a list ranging in size from 11 to 17 concept words with a median of 14 concept words. The paramedic students were given a list ranging in size from 9 to 15 concept words with a median of 13 concept words. The students in each course were tasked with constructing their own concept maps from the concept word list provided for each concept mapping assignment.

Prior to the first concept map assignment in each class, the students were briefly shown how to construct a concept map and examples of concept maps. The students in the immunology course were allowed to construct their maps using any method they preferred. The students in the paramedic cohorts were taught how to use Cmap Tools software (Institute for Human and Machine Cognition) and part of their assignment was to construct the concept map using the CMap Tools software. In summary, the immunology students voluntarily completed the concept maps for 10 different lecture topics during the semester for extra credit. The paramedic students completed their concept maps as coursework for 2 or 3 topics (depending on their cohort). Both sets of

students were given brief training in how to construct a concept map and provided with a list of concepts to include in each of their maps.

Now that I have discussed the story behind the development of the SMART method and provided some contextual background about the study populations and their concept maps, I will describe how to perform the SMART method in detail. The SMART method for analyzing concept maps (Table 5) was developed during the analysis of the immunology students' maps. The paramedic students' maps were analyzed using the SMART method as described in Table 5. The main emphasis while analyzing the paramedic students' concept maps with the SMART method was to examine the value of the method to the course instructor. I will discuss the findings from that study in Chapter 6.

Overview of the Chapter

Throughout the remainder of this chapter, I will explain how to use the SMART method through a variety of figures and tables. The first, Table 5, outlines the procedure for performing the SMART method. Then I will briefly discuss a simplified example of how to use the SMART method (Figure 6). Next I will walk the reader through the SMART analysis of the diabetes concept maps from the first cohort of paramedic students (Figures 7-11 and Tables 6 & 7). As I describe each figure and table, I will highlight some of the important features of the SMART method.

The procedure for performing the SMART method is outlined in Table 5. The SMART method consists of six steps: 1) coding the instructor's map, 2) coding the students' maps, 3) keeping track of and tallying the use of each code on worksheets (See Appendix B), 4) calculating the percentage of students' maps assigned each code, 5) setting the thresholds for highlighting instructor expected and student generated propositions, and 6) constructing the composite map.

Table 5. Procedure for the Salient Map Analysis for Research and Teaching (SMART) Method.

1. Assign number codes to the propositions on the instructor's expected concept map. (ie. 1, 2, 3…n)

2. Analyze each student's concept map by:
     a. Assigning the number codes to propositions on the student's map that are qualitatively similar to the propositions on the instructor's map.
     b. Assigning letter codes to propositions on the student's map that are not qualitatively similar to the propositions on the instructor's map.

3. Keep separate lists tallying each number code (instructor expected proposition) and letter code (student generated proposition). See Appendix B for the worksheets.
4. Calculate the percentage of students' maps that were assigned each number code (instructor expected proposition) and letter code (student generated proposition).

5. Set the thresholds for highlighting:
     a. Instructor expected propositions that appear on less than X percent of the students' concept maps. In this paper, this threshold was set at 50%.
     b. Student generated propositions that appear on X percent or more than of students' concept maps. In this paper, this threshold was set at 25%.

6. Construct a composite map by depicting:
     a. Instructor expected propositions (number codes) appearing on 50% or more of the students' concept maps (threshold set in step 5) in black text.
     b. Instructor expected propositions (number codes) appearing on less than 50% of the students' concept maps (threshold set in step 5) in **red** or **bold** text.
     c. Correct student generated propositions (letter codes) appearing on 25% or more of the students' concept maps (threshold set in step 6) in BLUE or CAPITAL text.
     d. Incorrect student generated propositions (letter codes) appearing on 25% or more of the students' concept maps (threshold set in step 6) in *GREEN* or *ITALICS CAPITAL* text.
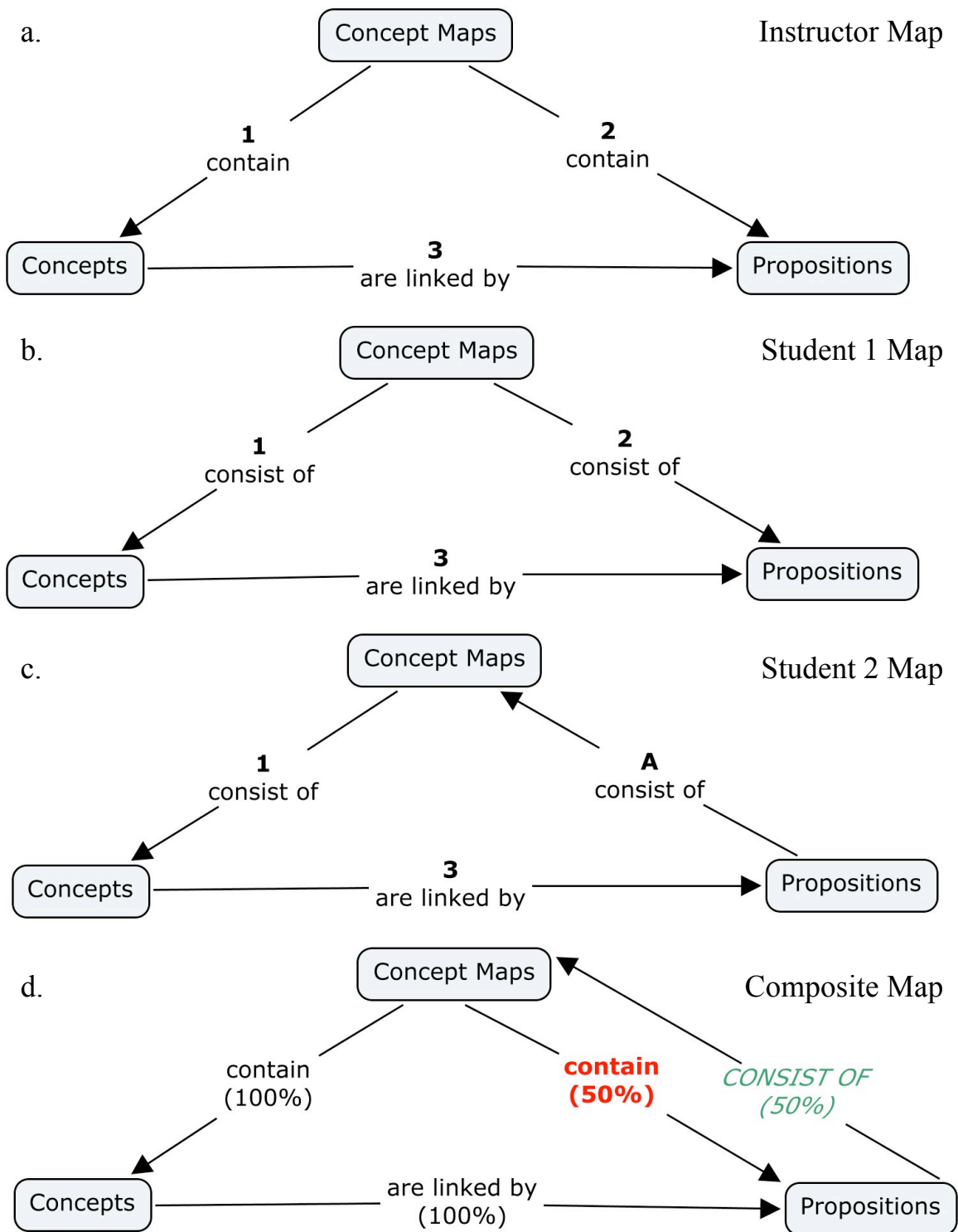
Figure 6. Sample Composite Map (d) from the SMART Analysis of Two Student Concept Maps (b & c) in Comparison to an Instructor's Concept Map (a). Concepts are depicted in the rounded boxes. Propositions are represented by the labeled arrows connecting two concept boxes. a,b,c) Number codes represent qualitatively similar Instructor Expected Propositions. Letter codes represent qualitatively similar student generated propositions. d) Parentheses below propositions represent the percent of students' maps containing a qualitatively similar proposition. The proposition in **bold red** text is highlighted because it represents an instructor expected proposition appearing on only 50% of the students' maps. The *ITALICS CAPITAL GREEN* text is highlighted because it represents an incorrect student generated proposition appearing on 50% of the students' maps.

Figure 6 is an abstract example of using the SMART method to analyze two students' concept maps (Figure 6b & 6c) in comparison to an instructor's map (Figure 6a). The product of this simplified analysis is an example composite map (Figure 6d). All of the concepts in the following figures are drawn in rounded boxes. The propositions are depicted as the labeled arrows connecting two concept boxes.

Instructor Expected vs. Student Generated Propositions

The SMART method differentiates between instructor expected propositions and student generated propositions. Number codes are used for instructor expected propositions that appear on the instructor's concept map (Figure 6a). Letter codes are used for student generated propositions that are unique to students' maps (Figures 6b & 6c) and do not appear on the instructor's map. Instructor expected propositions represent those ideas that were salient to the teacher based upon learning objectives. Student generated propositions represent those ideas that were salient to the student, but not the instructor. Instructor expected propositions are depicted in the composite map (Figure 6d) as black text if they appeared on at least half of the students' maps. If an instructor expected proposition is depicted on less than half the students' maps then it is highlighted in **red** or **bold** text. Student generated propositions are depicted in the composite map (Figure 6d) when they appear on at least a quarter of the students' maps. Correct student generated propositions are depicted in BLUE or CAPITAL text. Incorrect student generated propositions are depicted in *GREEN* or *ITALICS CAPITAL* text. The percentage of students' maps containing each proposition is shown in parentheses below each proposition in the composite map (Figure 6d). Now that I have shown a simplified

48

example of the SMART method in the abstract, I will describe how the SMART method was used to analyze the diabetes concept maps from the first paramedic cohort.

Example SMART Analysis of Diabetes Concept Maps

Using Figures 7 through 11 and Tables 6 and 7, I will describe the analysis of the first paramedic cohort's diabetes concept maps. Figure 7 depicts the coded instructor's expected concept map about diabetes. Figures 8, 9, and 10 depict the coded concept maps of students' 1, 2, and 5. Tables 6 and 7 are samples of the instructor expected and student generated propositions worksheets, respectively, from the diabetes analysis. Figure 11 is the final product of the SMART analysis of the diabetes concept maps, the composite map.

First let's look at the instructor's expected concept map about diabetes (Figure 7). The arbitrarily assigned number codes have been added to the propositions in the map to depict the first analysis step. This is the concept map from which the concept list was derived and assigned to the students to construct their maps. Each student's map is examined for the presence of qualitatively similar propositions to the ones depicted on this map.
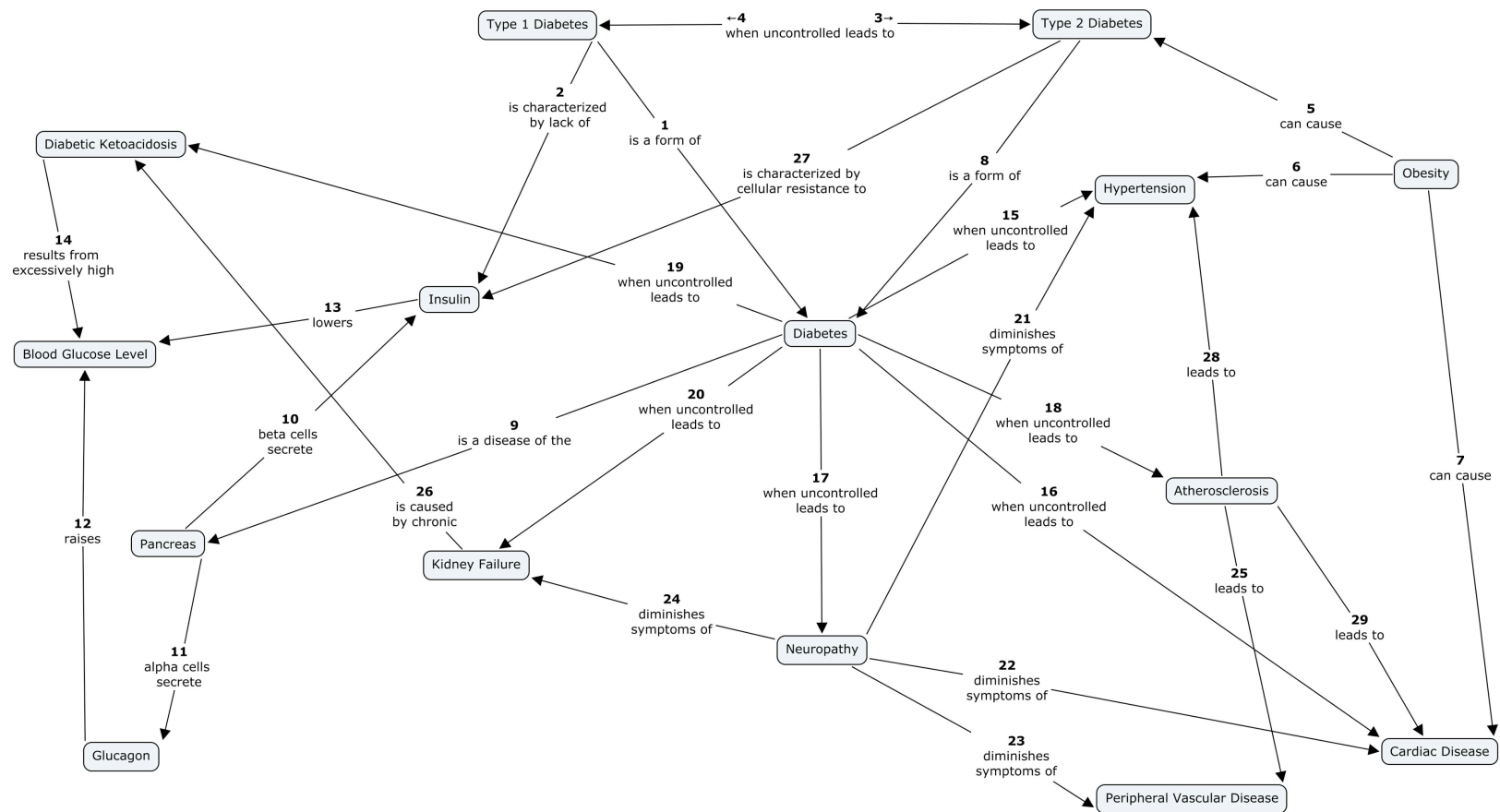
Figure 7. Instructor Predicted Diabetes Map with Codes. Concepts are depicted in the rounded boxes. Propositions are represented by the labeled arrows connecting two concept boxes. Number codes were arbitrarily assigned to the propositions. The number codes are represented as **bold** numbers above each proposition.

Qualitatively Similar Propositions

A qualitatively similar proposition depicts the same idea, using different words. When using the SMART method to assign number and letter codes to students' propositions, it is important to look for qualitatively similar ideas, not identical ideas or phrases. Ultimately the final decision regarding which propositions are qualitatively similar versus unique should rest with the course instructor.

Figure 8 depicts Student 1's diabetes concept map. The number and letter codes have been added in bold text above each proposition. The numerically coded propositions in Figure 8 can be compared to the corresponding propositions in Figure 7 for examples of the types of ideas that were considered qualitatively similar. An example is number code 17 which reads, "Diabetes when uncontrolled leads to neuropathy," in Figure 7, the instructor's map and "Neuropathy is a complication of diabetes," in Figure 8, student 1's map. These two ideas were considered qualitatively similar by the course instructor and therefore coded the same. Student 1's concept map is relatively easy to interpret and code the propositions compared to the concept map drawn by Student 2 (Figure 9). Next I am going to highlight some interpretation challenges that I encountered while using the SMART method.
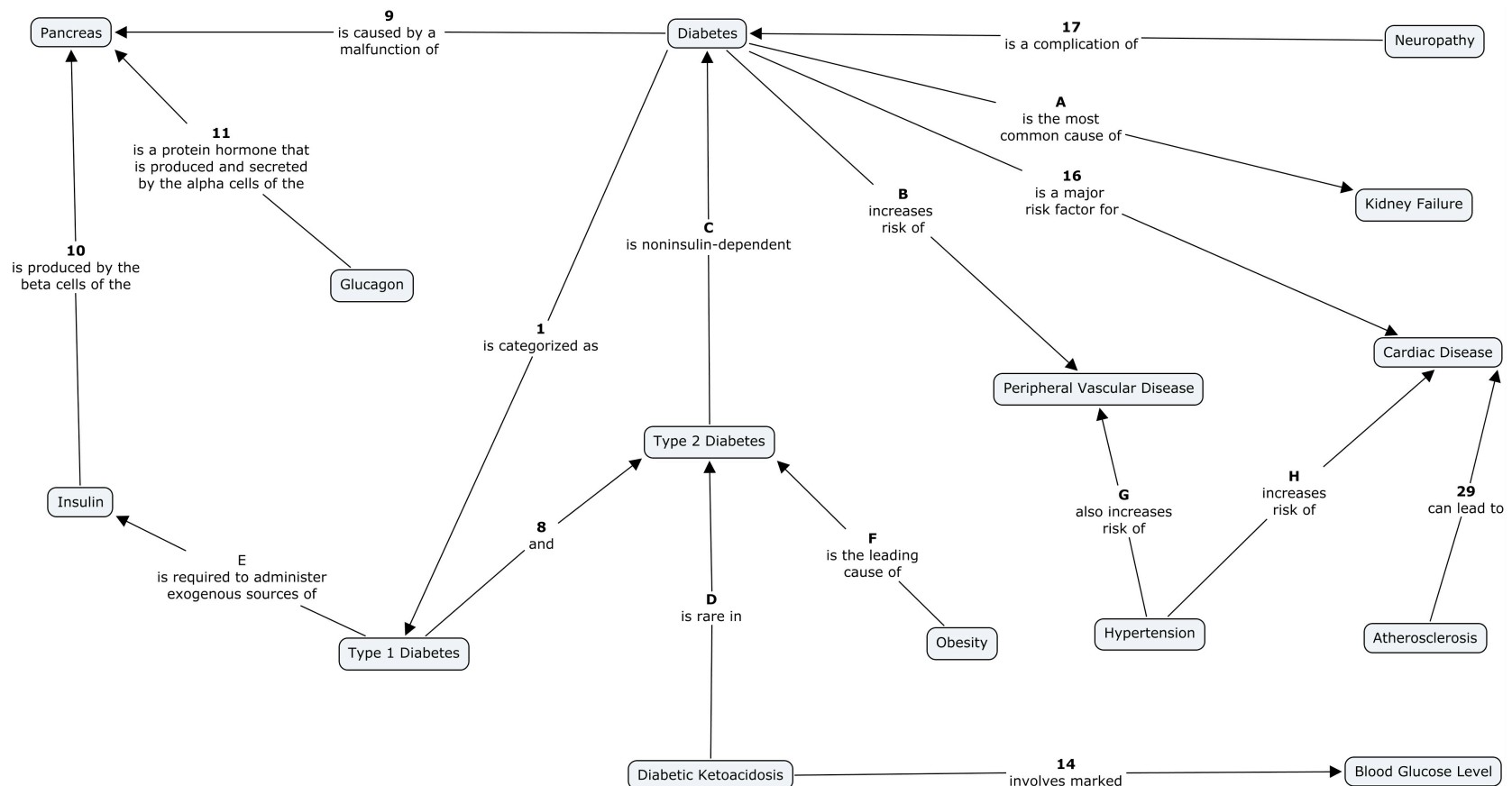
Figure 8. Student 1 Diabetes Map with Codes. Concepts are depicted in the rounded boxes. Propositions are represented by the labeled arrows connecting two concept boxes. Number codes represent propositions that are qualitatively similar to instructor expected propositions. Letter codes represent student generated propositions.

Interpretation Challenges

Some of the students' concept maps had portions that were challenging to interpret. One of the interpretation challenges was making sense out of the student's word choice when the meaning was not immediately clear. This interpretation challenge is not unique to concept mapping and potentially occurs during any free-response assessment. Rather than focus on this common educational challenge; instead, I am going to highlight an interpretation challenge that occurred during this study that is unique to concept mapping.

The interpretation challenge unique to concept mapping is non-directional propositions. Some students' concept maps have linking lines between concepts without arrowheads to indicate directionality. No matter the intention of the student or reason for the non-directional proposition, this can pose interpretational challenges. I am going to briefly discuss non-directional propositions. For a more detailed discussion of the theoretical considerations behind interpreting non-directional propositional statements, please refer to Appendix C.

Student 2 (Figure 9) has numerous examples of non-directional propositions throughout their map. This creates an interpretation problem because the propositional statement can then be read in two different directions. For instance, the linking line between the two concepts, insulin and pancreas is non-directional (Figure 9, Code 10). This statement could be interpreted two ways: 1) "pancreas secretes insulin" or 2) "insulin secretes pancreas." This particular non-directional proposition was relatively easy to interpret because the student had directionality in their corresponding propositional statement, "pancreas secretes glucagon." This made it

relatively easy to infer that the student's intended meaning was "pancreas secreting insulin." However, other non-directional propositions are much more challenging to interpret.

One difficult to interpret portion of student 2's concept map (Figure 9, codes 5 & 7) consists of three concepts, "obesity," "cardiac disease," and "type 2 diabetes," linked together by one propositional statement and two linking lines. Only one linking line has an arrowhead, pointing towards cardiac disease, which makes interpreting directionality of the other linking lines challenging. There are three possible ways to interpret the linking line with an arrowhead from this grouping: 1) "obesity is a risk factor for cardiac disease," 2) "type 2 diabetes is a risk factor for cardiac disease, " or both. Depending on which interpretation is chosen above, there are two additional ways to interpret the remaining propositional statement out of the grouping: "obesity is a risk factor for type 2 diabetes" or "type 2 diabetes is a risk factor for obesity." In this particular case, it was decided to code these propositions as if they were qualitatively similar to the instructor's expected propositions: "obesity can cause cardiac disease" and "obesity can cause type 2 diabetes." For a more in depth discussion of the potential errors involved with making this decision, please refer to Appendix C.
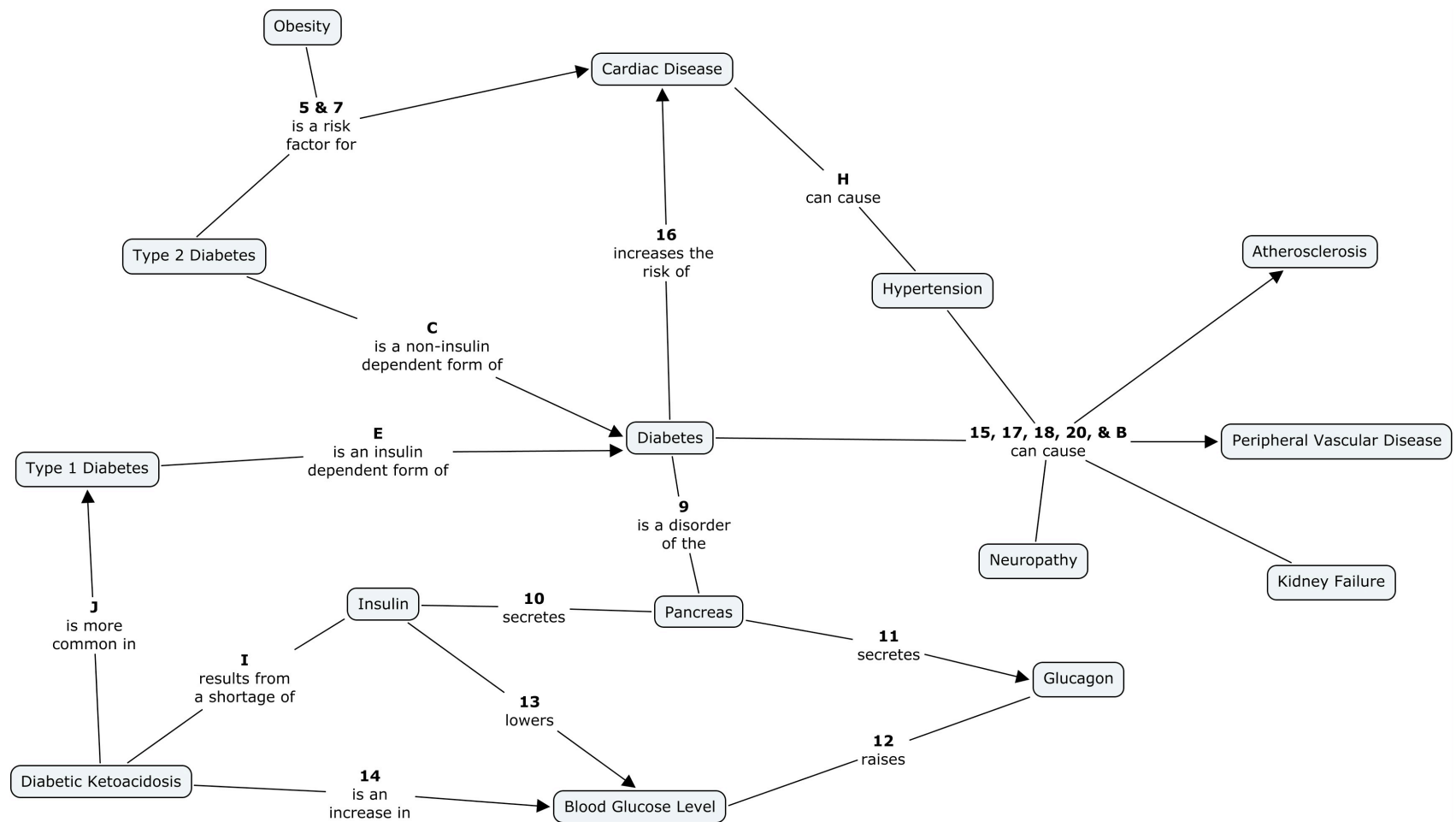
Figure 9. Student 2 Diabetes Map with Codes. Concepts are depicted in the rounded boxes. Propositions are represented by the labeled arrows connecting two concept boxes. Number codes represent propositions that are qualitatively similar to instructor expected propositions. Letter codes represent student generated propositions. Note the lack of directional arrows on some of the linking lines. For instance, between the concepts "obesity," "type 2 diabetes," and "cardiac disease." Also note the multiple use of the same proposition between these same concepts.

It is important to note that student 5's concept map (Figure 10) also depicts some propositional statements linked to more than two concepts. In student 2's concept map the linking of more than two concepts to the same propositional statement was performed in such a manner that many of the linking lines lacked arrows (see Figure 9 center right or top left). However, student 5 demonstrated that it is possible to link more than two concepts together with one propositional statement and still retain clarity of meaning by ensuring arrowheads are present to indicate directionality (see Figure 10 top left of center, codes 1 & 8).

CmapTools, the software program the paramedic students used to construct their concept maps, has settings to control arrowheads on the linking lines. Please refer to Appendix D for a discussion of how it is possible for a user of the software to accidentally omit some directional arrows from their concept map. Now that I have discussed how to code the concept maps using the SMART method and highlighted some of the interpretation challenges, I am going to discuss the worksheets I use to track the codes.
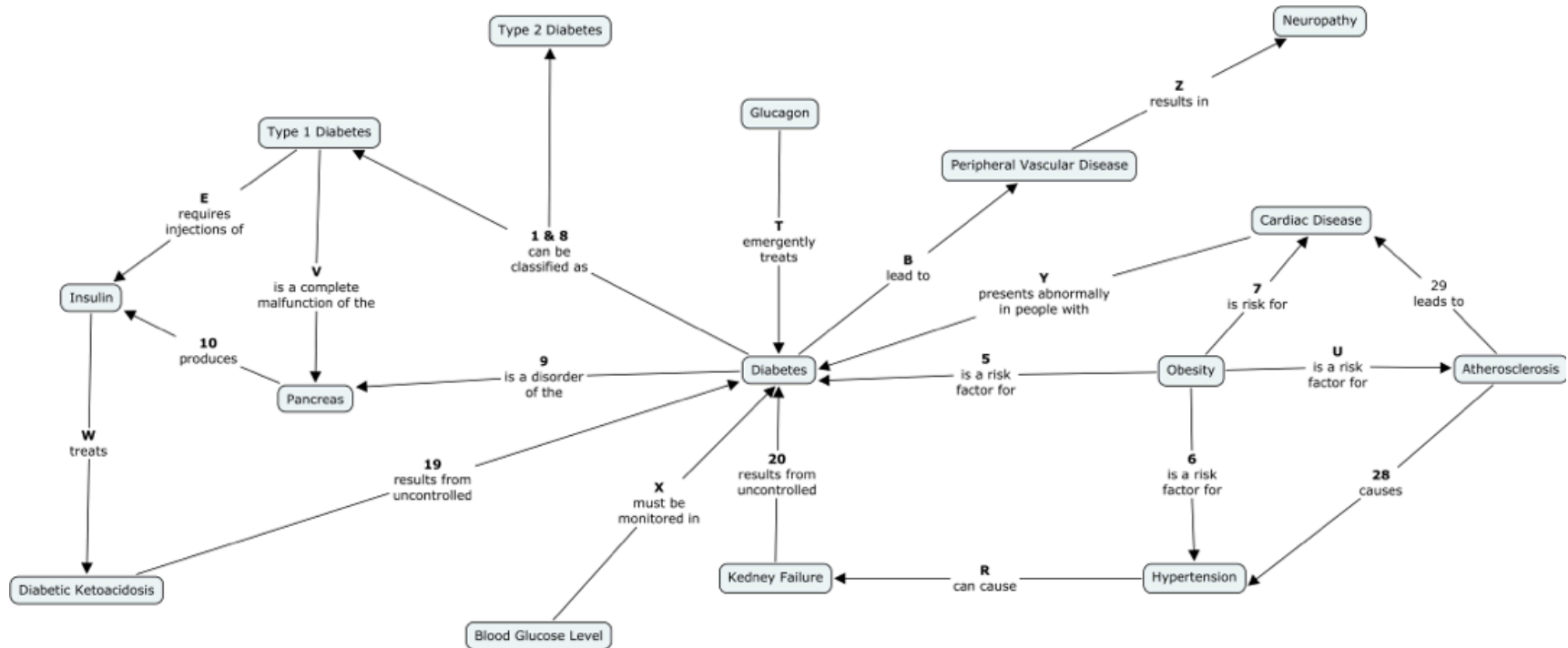
Figure 10. Student 5 Diabetes Map with Codes. Concepts are depicted in the rounded boxes. Propositions are represented by the labeled arrows connecting two concept boxes. Number codes represent propositions that are qualitatively similar to instructor expected propositions. Letter codes represent student generated propositions. Note the multiple use of the same proposition linking the concept "diabetes" to the concepts "type 1 diabetes" and "type 2 diabetes."

Data Analysis Worksheets

Worksheets are used to track the instructor expected and student generated propositions on students' concept maps. Tables 6 and 7 are excerpts from the worksheets filled out during the SMART analysis of the diabetes concept maps. Both worksheets are used to tally the number of students' concept maps that have been assigned each code. From this count the percentage of students' maps containing each instructor expected or student generated proposition can be calculated. Then this data is used to construct the composite map. Before I explain how to construct the composite map, I am going to explain how to use the worksheets.

The worksheet for instructor expected propositions (Table 6) contains four columns: 1) number code, 2) qualitatively similar propositions, 3) tally of students' maps assigned code, and 4) percentage of students' maps assigned code. To begin filling out this worksheet, the instructor expected propositions from the instructor's concept map are listed on the worksheet and assigned number codes. The propositions are written so that the concepts sandwich the linking words, which are underlined.

As each student map is analyzed, the coding of qualitatively similar propositions to the instructor expected propositions is tracked on this worksheet by making a tally mark and assigning the corresponding number code to the student's qualitatively similar proposition on their map. It is also possible to track the exact wording of the students' qualitatively similar propositions on this worksheet. For the immunology set of data, I found this step helpful because I performed the analysis separate from the course instructor. It helped to have a ready to reference list of all the propositions I considered qualitatively similar when he checked my analysis for validity. This list of students'

qualitatively similar propositions allowed us to easily discuss the coding. For the

paramedic set of data, I did not find it helpful to write the students' qualitatively similar

propositions in addition to the instructor's expected propositions, since the course

instructor and I analyzed the students' maps together. Only the instructor's expected

propositions, not the students' qualitatively similar ones are reflected in the qualitatively

similar proposition column in Table 6. In Table 7, I will show examples of students'

qualitatively similar propositions.

Table 6. Sample Worksheet Coding Instructor Expected Propositions. The column labeled "Number" represents the numerical codes arbitrarily assigned to the instructor expected propositions. Each qualitatively similar proposition is listed so that the concept words are capitalized and flanking the underlined linking words. The verbatim wording from the instructor's expected concept map represents each qualitatively similar proposition. The column labeled tally represents the number of student maps on which a qualitatively similar proposition appeared. (n=9) The column labeled percentage represents the percentage of student maps on which a qualitatively similar proposition to each instructor expected proposition appeared. Note that numerical codes 16-29 are not depicted in this Table.

Number	Qualitatively Similar Propositions (Concept <u>linking words</u> Concept)	Tally	Percentage
1	Type 1 Diabetes <u>is a form of</u> Diabetes	8	89%
2	Type 1 Diabetes <u>is characterized by a lack of</u> Insulin	1	11%
3	Type 1 Diabetes <u>when uncontrolled leads to</u> Type 2 Diabetes	0	0%
4	Type 2 Diabetes <u>when uncontrolled leads to</u> Type 1 Diabetes	0	0%
5	Obesity <u>can cause</u> Type 2 Diabetes	7	78%
6	Obesity <u>can cause</u> Hypertension	2	22%
7	Obesity <u>can cause</u> Cardiac Disease	5	56%
8	Type 2 Diabetes <u>is a form of</u> Diabetes	8	89%
9	Diabetes <u>is a disease of the</u> Pancreas	6	67%
10	Pancreas <u>beta cells secrete</u> Insulin	9	100%
11	Pancreas <u>alpha cells secrete</u> Glucagon	8	89%
12	Glucagon <u>raises</u> Blood Glucose Level	1	11%
13	Insulin <u>lowers</u> Blood Glucose Level	2	22%
14	Diabetic Ketoacidosis <u>results from excessively high</u> Blood Glucose Levels	3	33%
15	Diabetes <u>when uncontrolled leads to</u> Hypertension	2	22%

Table 7. Sample Worksheet Coding Student Generated Propositions. The column labeled "Letter" represents the letter code arbitrarily assigned to the student generated propositions. If applicable, the corresponding number or letter code from a similar, but qualitatively different proposition is recorded. Each qualitatively similar proposition is listed so that the concept words are capitalized and flanking the underlined propositions. The exact wording of the proposition was chosen to best represent the consensus qualitatively similar proposition expressed by the students. Each student generated proposition is categorized as either correct or incorrect based upon the instructor's interpretation and course instruction. The column labeled tally represents the number of student maps on which a qualitatively similar proposition appeared (n=9). The column labeled percentage represents the percentage of student maps on which a qualitatively similar proposition to each student generated proposition appeared. Note that the student added a new concept, Retinopathy, to their map in the proposition coded "O". Note that letter codes P-DD are not depicted in this Table.

Letter	Related Codes	Qualitatively Similar Propositions (Concept <u>linking words</u> Concept)	Correct vs. Incorrect	Tally	%
A	20	Diabetes <u>is the most common cause of</u> Kidney Failure	Correct	1	11%
B	17/23	Diabetes <u>increases risk of</u> Peripheral Vascular Disease	Correct	8	89%
C		Type 2 Diabetes <u>is non-insulin dependent</u> Diabetes	Incorrect	2	22%
D	See J	Diabetic Ketoacidosis <u>is rare in</u> Type 2 Diabetes	Correct	1	11%
E	2	Type 1 Diabetes <u>is characterized by dependence on</u> Insulin	Correct	4	44%
F	5	Obesity <u>is the leading cause of</u> Type 2 Diabetes	Correct	1	11%
G		Hypertension <u>also increases risk of</u> Peripheral Vascular Disease	Correct	2	22%
H	See BB[1]	Hypertension <u>increases risk of</u> Cardiac Disease	Correct	2	22%
I		Diabetic Ketoacidosis <u>results from a shortage of</u> Insulin	Correct	1	11%
J	See D	Diabetic Ketoacidosis <u>is more common in</u> Type 1 Diabetes	Correct	1	11%
K	12	Glucagon <u>will control</u> Blood Glucose Level	Correct	2	22%
L	13	Insulin <u>will control</u> Blood Glucose Level	Correct	2	22%
M	See CC[2]	Blood Glucose Level <u>exceeding normal limit will cause</u> Diabetes	Incorrect	2	22%
N	19	Type 1 Diabetes <u>may result in</u> Diabetic Ketoacidosis	Correct	4	44%
O		Diabetes <u>complication is</u> Retinopathy	Correct	1	11%

The student generated propositions worksheet (Table 7) contains the same four columns as the instructor expected propositions worksheet, however, there are two additional columns added to the student generated propositions worksheet. The first additional column identifies the number or letter codes of propositions that are similar, but qualitatively different, to the student generated propositions. This column is called "related codes." I added this column to the worksheet at the request of the paramedic instructor. She found the additional organization of the student generated propositions helpful in her thinking about the students' maps during the SMART method process. The second additional column categorizes the student generated propositions as correct or incorrect. The decision to categorize a student generated proposition as correct or incorrect was ultimately left up to the course instructor based upon course content and learning objectives.

In this paper, the SMART method differentiates student generated propositions based upon correctness; however, it is possible to use a different factor to differentiate the student generated propositions, or for there to be no differentiation at all. For instance, the student generated propositions could be differentiated based upon type of scientific reasoning: natural or social science. Angel, the paramedic instructor, suggested at one point during our analysis of the paramedic students' maps that a mostly correct categorization would be helpful in addition to the correct and incorrect.

Angel: You oughta have another con... thing here for umm instead of making it a fifty-fifty you oughta have a code here that's you know going the right direction but not quite type of a code. You know what I mean?
Laura: Ohh
Angel: Like they're on track but they're just not there yet.
Laura: [laughter] Huh. Like a...
Angel: Mostly correct, or partially correct.
Laura: Like maybe a number scale, like a Likert scale instead of correct

versus incorrect, like a Likert scale in terms of how correct.

Angel: Well ya one is correct, well one is correct, er one is incorrect, three is incorrect and two is on that continuum in the middle.

The remaining columns in the student generated propositions worksheet (Table 7) are filled out in the same way as the instructor expected propositions worksheet (Table 6) except for the qualitatively similar propositions column. The first time each student generated proposition is identified during the analysis, it is recorded on the student generated propositions worksheet, assigned a letter code, and a tally is made. If later in the analysis, another student's map contains a qualitatively similar proposition to an already recorded student generated proposition, another tally is made and the letter code is assigned to the student's proposition. The exact wording for the student generated propositions evolves as the number of students' maps containing a qualitatively similar proposition increases. Inevitably the final wording of the proposition is chosen to best represent the consensus idea expressed by the students.

Occasionally, in addition to student generated propositions, students' maps contained student generated concepts. Remember that for all of the concept map assignments in both the immunology and paramedic courses, the students were provided with lists of concept words to include in their concept maps. Sometimes a student would still add one, or more, additional concept words to their map. An example is depicted in letter code "O" in Table 7 with the concept "retinopathy." Rarely students added the same additional concepts to their maps causing the threshold to be reached for inclusion of a student generated concept in the composite map. Next I will describe the construction of the composite map based upon the SMART analysis.

Composite Map Construction

The product of the SMART analysis is a composite map (Figure 11) that depicts both visually and quantitatively, the similarities and differences between the instructor's expected concept map and the students' concept maps. Both the instructor expected proposition worksheet (Table 6) and student generated proposition worksheet (Table 7) are used to construct the composite map. The instructor's expected map (Figure 7) serves as the starting point for the composite map. The percentage of students' maps containing each instructor expected proposition is listed in parentheses below each proposition. At this point the map only contains instructor expected propositions, so the listed percentages serve as the guide for highlighting the text. The thresholds for highlighting the propositions are flexible depending on the goals of the user of the SMART method. In this paper, those propositions with percentages of 50% or more are left as black text. These plain black text propositions represent portions of the concept map where the instructor's expectations are similar to the students' propositions on their concept maps. The instructor's expected propositions appearing on less than 50% of students' maps are highlighted in **red** or **bold** text. The **red** or **bold** text draws attention to propositions that the instructor expected are salient to the map topic, but over 50% of students' maps differed and did not contain the highlighted propositions.

Next, the student generated propositions (Table 7) that appeared on 25% or more of the students' maps are added to the composite map. Each proposition is highlighted depending on whether the student generated proposition was categorized as correct or incorrect by the course instructor. Correct student generated propositions are highlighted in BLUE or CAPITAL text. Incorrect student generated propositions are highlighted in

GREEN or *ITALICS CAPITAL* text. Each student generated proposition that is highlighted on the composite map, whether correct or incorrect, represents a convergence of at least 25% of the students' concept maps to contain a qualitatively similar proposition.

In summary, the composite map is constructed from the coded map data that was tracked on the Instructor's Expected Propositions and the Student Generated Propositions worksheets. The product composite map of the SMART analysis depicts both the convergence of students' concept maps upon similar ideas and the divergence of students' concept maps from instructor's ideas. These properties make the SMART method of analyzing concept maps a powerful formative assessment tool.

The Salient Map Analysis for Research and Teaching (SMART) Method for analyzing concept maps was designed to provide actionable data to instructors from students' concept maps. In the next section of this chapter, I will outline some of the types of actionable information that the SMART method is capable of highlighting in a set of students' concept maps.
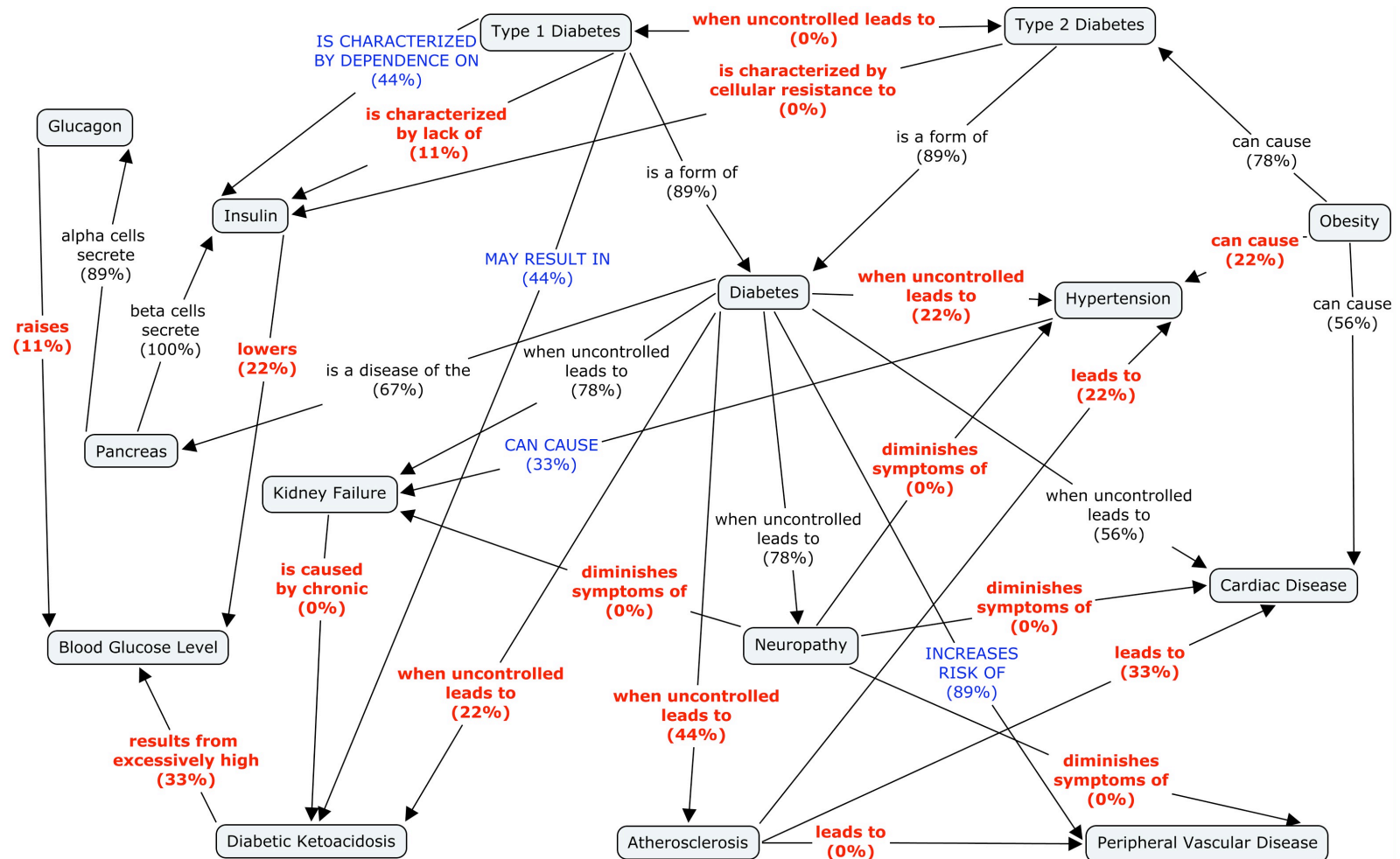
Figure 11. Diabetes Composite Map (n=9). Concepts are depicted in the rounded boxes. Propositions are represented by the labeled arrows connecting two concept boxes. Parentheses below propositions represent the percent of students' maps containing the proposition. Propositions in black text are instructor expected propositions appearing on 50% or more of the students' maps. Propositions in **red** text represent instructor expected propositions appearing on less than 50% of the students' maps. Propositions in BLUE text represent correct student generated propositions appearing on more than 25% of the students' maps.

Chapter 4: The SMART Method as a Formative Assessment

The S in the SMART Method, Defining Saliency

In order to fully understand the SMART Method as a formative assessment tool, it is important to understand what is meant by the term salient, in the acronym Salient Map Analysis for Research and Teaching. For the purposes of this dissertation, salient ideas are defined as the most important, obvious, or relevant ideas to the topic in the given context at a specific moment in time. This means that when operationalizing this definition, the salient ideas are the ones that appear on a concept map. It is likely that this definition of salient is too narrow, and does not encompass all of the possible reasons why a specific idea was given attention by an individual and included as a concept or proposition on their concept map. There are three slightly different ways to view salience depending on whether you approach it from the perspective of the instructor, the student, or are interpreting a composite map produced by the SMART method. And it is important to remember that there is a cognitive story behind each person's choices about what is salient to include on their concept map.

When an instructor is drawing the expected concept map, they are making decisions about which concepts and propositions to include in the map. These decisions are based not only on the course learning objectives, but also on the instructor's prior experience teaching the topic, and the context of the current course. It is likely that the instructor has put a lot of thought into these ideas and that they are fairly robust or stable in comparison to students' ideas. The concepts and propositions included in the instructor's expected map are salient to the instructor at that moment in time.

When a student is constructing their concept map, they are making decisions about how the assigned list of concepts are related, and these ideas turn into the map's propositions. Their decisions about how the concepts are related are not only based upon what they have learned in class about this topic, but also on previous experiences, and the context in which the map is drawn. The average student is not likely to reflect upon their concept map as deeply as an instructor, so the propositions they choose to depict on their map are likely the first ideas that come to mind. The propositions included in each student's map are salient to the student at that moment in time.

When interpreting a composite map, the ideas salient to both the instructor and the students' are discernable. The instructor's expected propositions represent ideas salient to the map topic from the instructor's perspective. The student generated propositions represent ideas salient to the map topic from a minimum threshold number of students' perspectives. In addition to depicting these two types of salience, a third type of salience emerges from the composite map: prominent features of students' concepts maps as depicted by the composite map. It's important to remember here that the prominent features that appear in the composite map are affected by the decisions made about the threshold values to utilize during the construction of the composite map. The prominent features may include: 1) changes across time between composite maps, 2) identification of alternative conceptions, 3) identification of problematic concepts, and 4) dominant color patterns of the composite maps.

Changes Across Time

Another feature of the SMART method is the ability to highlight changes in students' concept maps across time (See Figure 12). Two of the sets of immunology

concept maps were drawn about similar developmental processes at different points during the semester. The first topic was B Cell Development at the beginning of the semester. The students had a lecture exam and completed two more concept mapping assignments before completing the T Cell Development concept maps. The initial development of both B and T Cells is similar, but then the two processes diverge. This unique circumstance allowed for the comparison of portions of the B and T Cell Development composite maps to look for changes across time.

At the beginning of both the B and T Cell Development concept maps, one of the instructor expected propositions was "Lymphoid Precursors interact with Stromal Cells." In the B Cell Development map this proposition, or a qualitatively similar one, only appeared on 30% of students' concept maps. Later in the semester, when the students
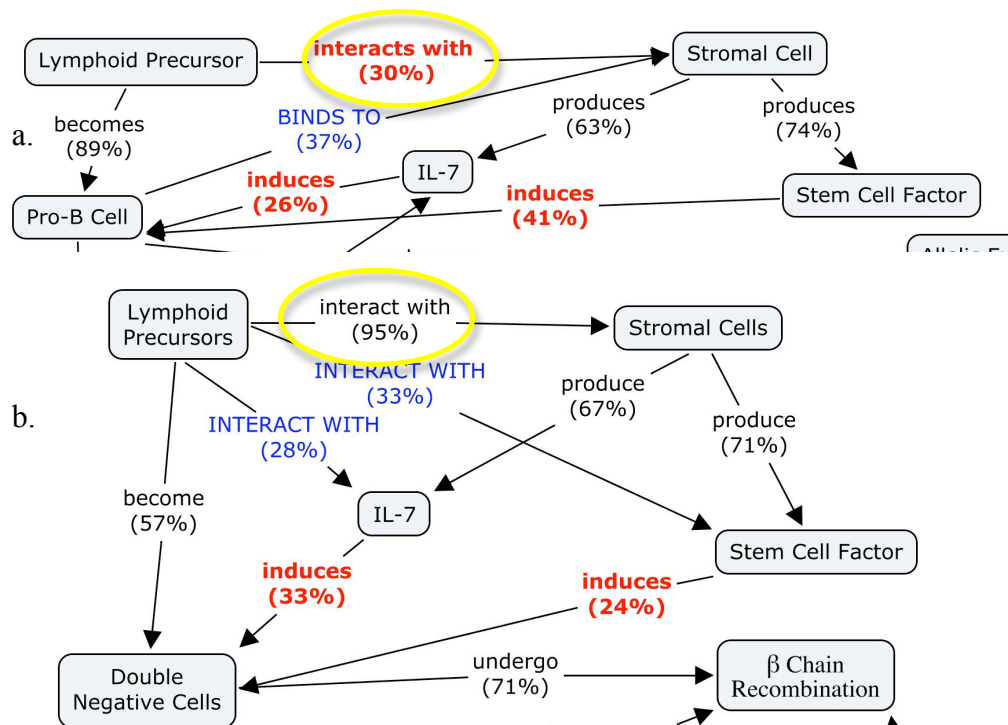
Figure 12. Change Across Time on the B Cell Development (a) and T Cell Development (b) Composite Maps. The propositions circled in yellow at the top of each composite map demonstrate a potential change across time in students' representation of this particular idea involved in the beginning of B and T Cell Development.

drew the T Cell Development concept maps, 95% of the students included this same

proposition, or a qualitatively similar one, on their concept maps. This is a dramatic

change in the percentage of students' who felt it salient to include the proposition

"Lymphoid Precursors interact with Stromal Cells" on their concept maps. Unfortunately,

due to the serendipitous nature of this finding, there is no data on the reasons for this

change.

Alternative Conceptions

The SMART method allows for the identification of alternative conceptions

(Figure 13). In this paper, alternative conceptions are defined as student generated

propositions that appear at a high enough threshold for depiction on the composite map.

These alternative conceptions do not appear on the instructor's expected map and in this

paper were categorized as either correct or incorrect student generated propositions.

Alternative conceptions that are correct are highlighted in BLUE text; whereas, incorrect

ones are highlighted in *GREEN* text. The threshold for including these student generated

propositions in the composite map was set so that only those propositions that had

qualitatively similar ideas depicted on at least 25% of the students' maps were

highlighted. There are several alternative conceptions about the concept "lipid rafts" in

the top right corner of the Costimulation composite map (See Figure 13). The incorrect

GREEN highlighted proposition, "Lipid rafts form into synapse," appears on 47% of the

students' maps. The correct BLUE highlighted propositions, "Lipid rafts reorganize to

form pSMAC" and "Lipid rafts reorganize to form cSMAC" also appear on 47% of the

students' maps. The students' included both correct and incorrect alternative conceptions

about the concept "lipid rafts" in their maps. Less than a third of the students (29%)
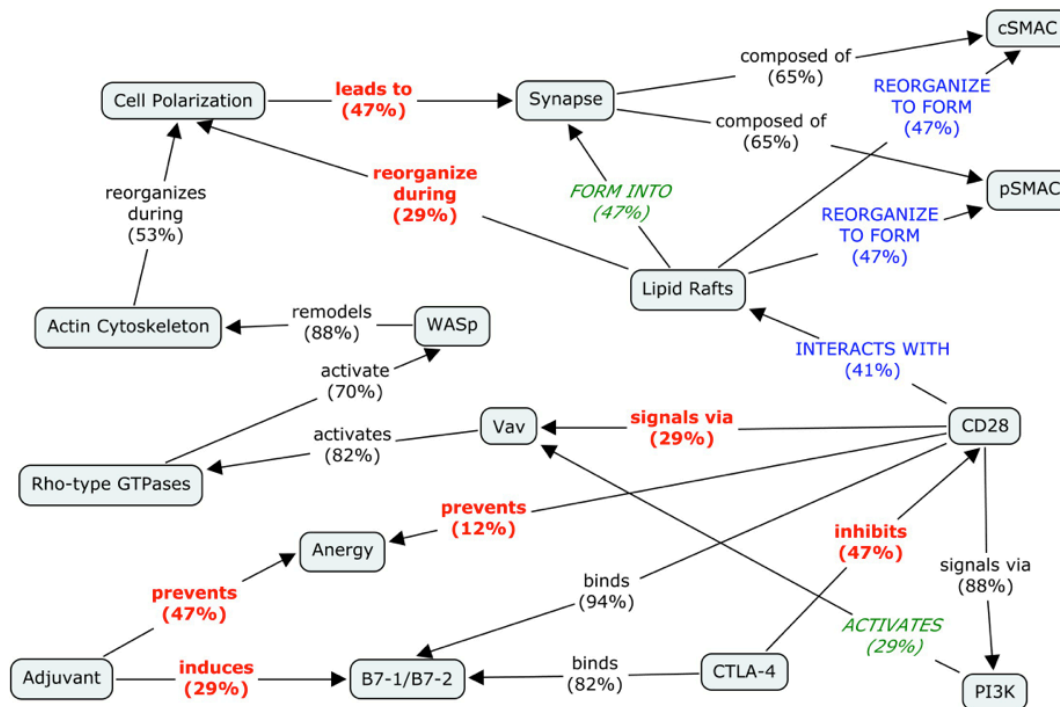
Figure 13. Alternative Conceptions on the Costimulation Composite Map. The BLUE and *GREEN* highlighted propositions originating from the concept "lipid rafts" are an example of alternative conceptions, instead of the instructor predicted **red** highlighted proposition originating from the concept.

included a qualitatively similar idea to the instructor's expected proposition, "lipid rafts reorganize during cell polarization" on their concept maps, so the proposition is highlighted in **red** on the composite map.

All of this information paints a fairly detailed picture of the differences between the students' and the instructor's thoughts about what ideas are salient to the concept "lipid rafts." At the same time a picture is beginning to emerge showing a similarity between many of the students' ideas about what is salient to the concept "lipid rafts."

There are two important distinctions to keep in mind regarding the BLUE highlighted propositions: 1) they could simply be correct statements where the student is thinking about the concept differently from the instructor or 2) they could be examples of ideas that the students' found salient to the topic at hand, but the course instructor did not

find salient nor include on their expected concept map. These propositions the instructor chose not to include on the concept map, may actually be salient to the topic and correct, just not in the context of the course or this particular concept mapping assignment.

Problematic Concepts

The SMART method is capable of highlighting particularly problematic concepts. A problematic concept as defined in this paper is one in which the majority of the propositions connected to the concept are highlighted in **red** and/or *GREEN* text. Propositions highlighted in **red** represent instructor expected propositions that appear on less than 50% of the students' maps. Propositions highlighted in *GREEN* represent incorrect student generated propositions that appear on 25% or more of students' maps. Negative selection is an example of a problematic concept on the T Cell Development composite map from the immunology cohort (See Figure 14). There are three propositions linked to the concept negative selection on the T Cell Development composite map. One proposition is highlighted **red**, the other two are highlighted *GREEN*. This means that a minority of the students felt it salient to include the instructor's expected proposition on their maps. Additionally, the students converged on two incorrect student generated propositions that they did feel were salient to include on their maps. From a formative assessment perspective, these **red** and *GREEN* highlighted propositions focus the instructor's attention on productive ways in which to begin readdressing the concept of negative selection in the classroom.
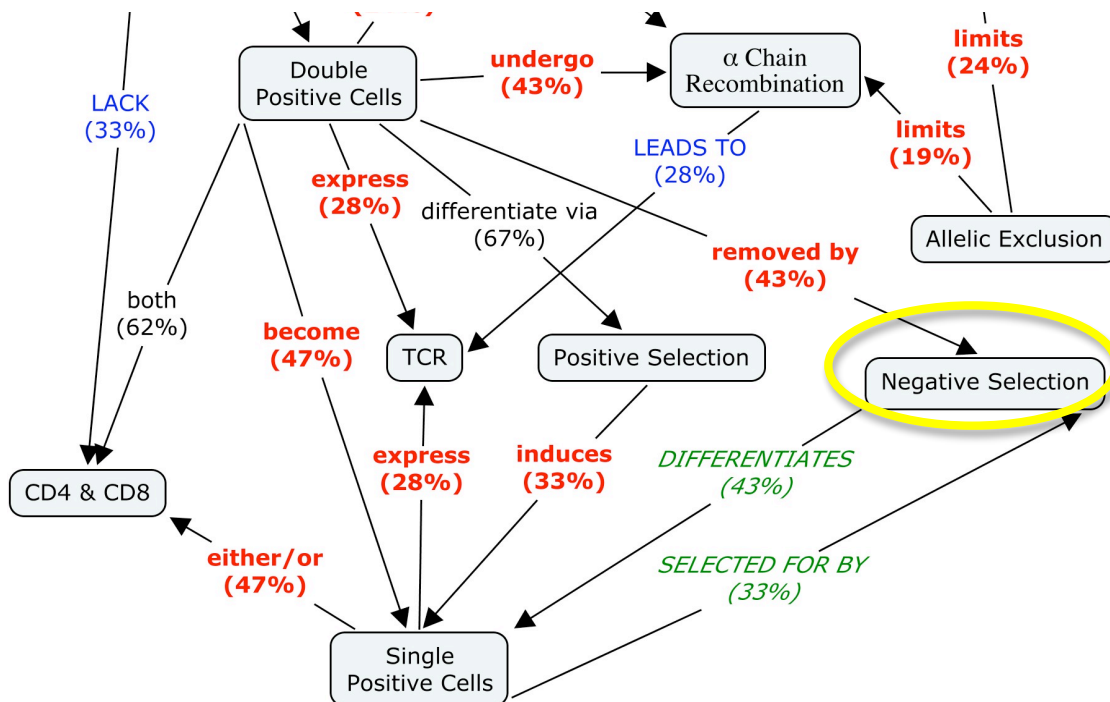
Figure 14. Problematic Concept on the T Cell Development Concept Map. The concept "Negative Selection" circled in yellow at the bottom of the T Cell Development map represents a problematic concept. There are only *GREEN* and **red** highlighted propositions connecting to this concept.

Interestingly, on the B Cell Development Map, negative selection did not appear to be a problematic concept. The only proposition linking to the concept negative selection on the B Cell Development composite map is non-highlighted black text. This means that a majority of the students found this proposition salient to their map as the instructor had predicted. Upon further examination of the raw data, students did have a variety of incorrect student generated propositions about negative selection on their B Cell Development maps; however, there was a larger variety of incorrect propositions, and the students did not converge upon any one idea enough for it to reach the 25% threshold for highlighting on the composite map.

As with all assessments, this particular identification of negative selection of a problematic concept is context specific. It is possible that if the students were asked to

draw the same concept map on a different day, their maps would include more or less correct propositions connecting to negative selection. It is also possible that a different assessment about negative selection would reveal a different picture about the concept. The important point here is that the SMART method provides instructors with a starting point to identify potentially problematic concepts and provides specific information about how to begin addressing those concepts in the classroom.

Color Patterns

The composite maps produced by the SMART analysis can be roughly categorized based upon the color patterns they depict. There are four possible colors in which text is highlighted in the composite map by the SMART method. Black text represents instructor expected propositions that appeared on 50% or more of the students' maps. **Red** text represents instructor expected propositions that appeared on less than 50% of the students' maps. BLUE text represents correct student generated propositions that appear on more than 25% of the students' maps. *GREEN* text represents incorrect student generated propositions that appear on more than 25% of the students' maps. Theoretically a large possible number of color patterns could emerge with varying numbers and proportions of each of these colors. In reality, a few specific color patterns dominated both the immunology and paramedic cohort composite maps (See Table 8).

Three color patterns emerged from the composite maps: black, **red**, and **red** & BLUE (See Table 8). These are general categories that emerged from talking with the instructors about the composite maps and hearing them say things like "Wow, this map has a lot of red compared to the others." When a composite map's color pattern is dominated by one color, such as black or **red**, then this means that a majority of the

propositions on the map are highlighted in that color. When a composite map's color

pattern is described as **red** and BLUE, this means that a majority of the propositions on

the map are highlighted in a combination of **red** and BLUE. Each of these different color

patterns has different theoretical implications to consider when interpreting a SMART

method composite map.

Table 8. Composite Map Color Patterns for Immunology and Paramedic Cohorts.

Immunology Course		First Paramedic Cohort	
Lecture Topics	**Composite Map Color Pattern**	**Lecture Topics**	**Composite Map Color Pattern**
B Cell Development	Black	Autonomic Nervous System	**Red**
Germinal Centers	**Red**	Diabetes	**Red**
Major Histocompatibility Complex	Black		
T Cell Development	**Red** & BLUE	**Second Paramedic Cohort**	
Costimulation	**Red** & BLUE	**Lecture Topics**	**Composite Map Color Pattern**
Cytokines	**Red** & BLUE	Autonomic Nervous System	**Red** & BLUE
Autoimmunity/Tolerance	Black	Respiratory Medicines	**Red** & BLUE
Alloreactivity/Immunosuppression	**Red** & BLUE	Shock	**Red** & BLUE
Vaccines	**Red** & BLUE		
Immune Responses to Tumors	**Red** & BLUE		

Black Dominated Color Pattern

First, let's take a look at the black dominated color pattern composite maps as these are the easiest to interpret (See Figure 15). When a composite map is dominated by black text propositions, this indicates that the teacher's expected concept map is fairly similar to the students' concept maps. This is a fairly straightforward positive outcome if using the concept mapping assignment as a formative assessment. In this
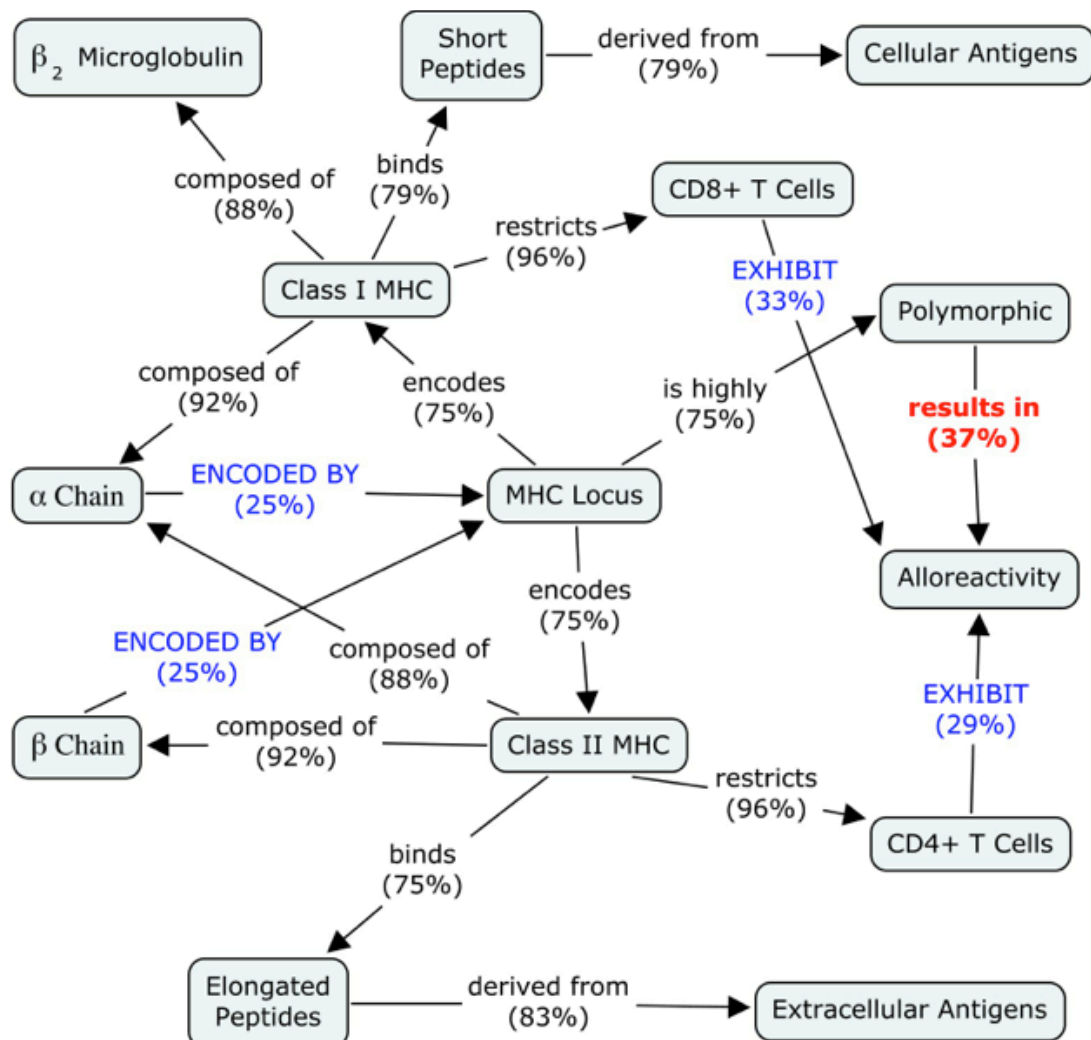
Figure 15. Black Dominated Color Pattern Composite Map. The Major Histocompatability Complex (MHC) composite map is an example of a composite map dominated by black text propositions. This indicates a high degree of similarity between the teacher's expected concept map and the students' concept maps.

case the teacher has drawn the predicted concept map to reflect what she feels is salient to the topics learning objectives. The students have demonstrated through their concept maps that what they feel is salient to the topic is similar to their teacher. What we cannot distinguish using the SMART method is whether the students superficially memorized the content and regurgitated it in the form of a concept map or meaningfully learned these concepts and then depicted this knowledge in their concept maps. The significance of the alignment of the teacher's and students' salient ideas about the topic is that everyone in this classroom is approximately on the same page.

Red Dominated Color Pattern

Now, let's take a look at the **red** dominated color pattern composite maps (Figure 16). When a composite map is dominated by **red** text propositions, this indicates that the teacher's expected concept map is different from the students' concept maps. Based upon the course learning objectives, the teacher included concepts and ideas salient to the topic in the expected concept map. However what the SMART analysis reveals and the composite map depicts is that a majority of the students did not include the same salient ideas as the teacher on their concept maps. In other words, the students likely did not get out of the lessons what the instructor intended. Assuming that the teacher's expected concept map accurately reflected concepts and ideas salient to the course learning objectives, this indicates that there may be some concepts and ideas that need more attention in the classroom. The SMART method has limitations though. It is possible that the students do understand these concepts and ideas, but did not find them salient to the concept mapping
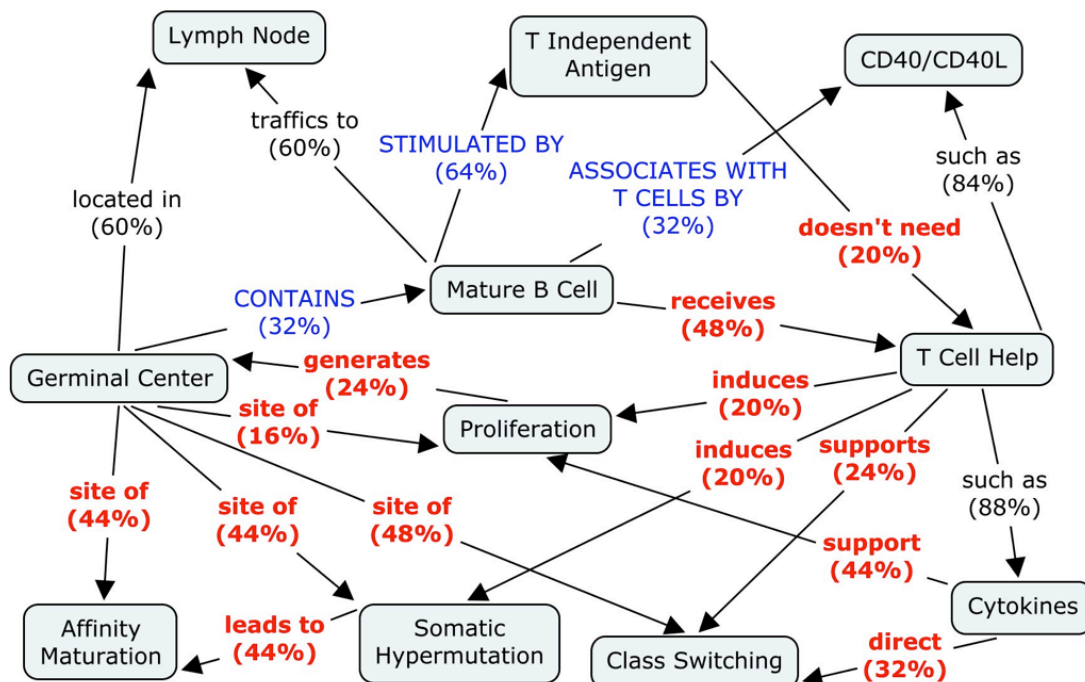
Figure 16. Red Color Pattern Dominated Composite Map. The Germinal Centers composite map is an example of a composite map dominated by **red** highlighted propositions. This indicates a divergence between the instructor's expected concept map and the students' concept maps.

assignment so did not include them in their maps. The significance of a **red** dominated composite map is that it can help the teacher to identify possible areas in which to spend more time in the classroom.

Red and BLUE Dominated Color Pattern

Perhaps the most interesting color pattern to emerge from the SMART analysis is the **red** and BLUE dominated composite maps (Figure 17). The **red** propositions on these maps indicate that the students' maps differed from the teacher's expected concept map. However, the BLUE propositions indicate that the students have included correct propositions on their maps that the teacher did not expect the students to include on their maps. What makes this color pattern so interesting is the combination of the **red** and BLUE propositions. This indicates divergence from the instructors expected map and convergence of the students upon

correct student generated ideas. This **red** and BLUE color pattern composite map is

particularly valuable as a formative assessment because it speaks to a disconnect

between the teacher and students ideas about a topic. The **red** propositions show that

what the students consider salient to include in their maps differs from what the

teacher considers salient. However, the story does not end there - these students also

Figure 17. Red and BLUE Color Pattern Dominated Composite Map. The Cytokine composite map is an example of a composite map dominated by **red** and BLUE highlighted propositions. This indicates a divergence of the students' maps from the instructor's expected map and a convergence of the students' maps upon correct alternative conceptions.

80

considered it salient to include additional correct student generated ideas about the topic in their maps.

In this case both the teacher and the students' have different thoughts about the salient ideas to the concept map topic. Perhaps the BLUE propositions in this case represent student ideas that are the precursors or building blocks to the ideas the instructor is looking for. The advantage to the SMART method that is highlighted here is that a teacher can visualize the progression of the development of ideas within the class. Whereas, a traditional scoring method of analyzing concept maps would only show the differences between the teacher's expected and the students' actual maps, not highlight the students correct developing ideas.

Theoretical Perspective Influencing Interpretation of Color Pattern

Depending on the theoretical perspective from which the instructor is approaching these maps, their interpretation of the meaning of these color patterns may vary a bit. For instance, when an instructor interprets a **red** dominated map, they can operate from the perspective that the students are lacking understanding of the propositions that are missing or that the students understand the propositions, but simply did not find them salient to include on their maps. These are two very different ways to approach interpreting a **red** dominated concept map and they lie on a continuum. It is likely that most instructors do not even make a conscious decision about how they are interpreting the map and their perspective may fall somewhere in the middle of the continuum.

In terms of the **red** and BLUE dominated map, most instructors would agree that the students are demonstrating alternative ideas about the topic. But where

instructors may differ depending on their perspective is on whether the students'

alternative ideas represent productive sense-making or off-topic, misguided ideas. An

instructor like Angel, the paramedic instructor I study in Chapter 6, who views her

students as novices is more likely to view the alternative ideas depicted in **red** and

BLUE maps as productive sense-making endeavors. Whereas some instructors may

simply see these alternative ideas as unproductive to the learning process. It's also

possible that the same instructor can vary their perspective depending on the specific

ideas expressed in the **red** and BLUE map. These perspectives described here are just

examples, but you begin to see how the instructor's theoretical perspective influences

the interpretation of the map's color pattern.

Advantages and Limitations

I want to take the opportunity to highlight some of the main advantages and

limitations of the SMART method. Besides the powerful features I have already

described, there are two main advantages: 1) the flexibility of the thresholds for

highlighting propositions on the composite map and 2) the capacity for the instructor

to interpret qualitatively similar propositions based on their courses' objectives. The

main limitation of the SMART method is that it does not easily apply to all concept

mapping assignments.

Threshold Flexibility

One of the biggest advantages of the SMART method is the flexibility to set

the thresholds highlighting propositions within the composite map depending on the

objectives of the analysis. In the studies in this dissertation, the instructor expected

proposition threshold was set at 50%. This threshold was set at 50% indicating the potential need for instructional intervention in the classroom as opposed to individual student errors. The student generated proposition threshold was set at 25%. This threshold was set at 25% indicating the possible presence of a shared alternative conception among students as opposed to an individual student's misunderstanding.

These thresholds can be adjusted, for instance, the lower the instructor expected proposition threshold (below 50%), the fewer propositions will be highlighted during the analysis and therefore any red highlighted instructor expected propositions become potentially more significant. If the threshold for student generated propositions is raised, then fewer propositions will be highlighted and any student generated propositions appearing on the composite map are potentially more robust. If either threshold is adjusted in the opposite direction, instructor expected proposition threshold greater than 50% or student generated proposition threshold less than 25%, the sensitivity of the SMART method is decreased. This may prove advantageous in some cases, for example, when the sample size is smaller in order to detect small effects. For example, on several occasions, the paramedic course instructor and I had discussions about lowering the student generated proposition threshold from 25% to 20%, because our sample size for each map was between 9 and 12 students, so the difference between these two thresholds was only the difference between two versus three students.

Interpretation of Qualitatively Similar Propositions

Another tremendous advantage of the SMART method is the instructor's discretion to interpret which propositions are qualitatively similar to each other. The

instructor can decide on a case-by-case basis what exact wording or unique expression of an idea is similar enough to be grouped together and what is just different enough to be split off into another code. And this is a fluid process, as the analysis is being performed on the maps and the propositions are being coded and tracked on the worksheets, an instructor can easily change their mind based on more ideas being expressed by the remainder of the class. For instance if an instructor initially decided to code two slightly different ideas as qualitatively similar because they were related, but subtly different ideas, they can later change their mind if they see a pattern developing that half the class is saying one and half the class is saying the other. It's important to keep in mind that this flexibility in interpreting what is qualitatively similar and what is unique is designed to serve the needs of the instructor in terms of learning more about their students' thoughts and how to continue with instruction.

Another tremendous benefit of the instructor interpreting which propositions are qualitatively similar or not, is the actual process of the instructor making the decisions. It provides the instructor an opportunity to immerse herself in thinking about subtle differences between students' ideas that is not easily afforded by many formative assessments.

Applicability to All Concept Mapping Assignments

Perhaps the biggest limitation of the SMART method is that it is not readily applicable to all concept mapping assignments. It easily applies to concept mapping assignments where the students' maps share a common list of concept words. But it is significantly more difficult to perform the SMART analysis on a set of students'

maps if they are completed from scratch without a shared concept list. During the course of my graduate studies, I had the opportunity to apply the SMART method to a set of student groups' concept maps from a pollinator course that did not share a common concept list. A fellow science education researcher, Dr. Kristi Hall, and myself spent countless hours over several weeks coding the students' maps. It took two rounds of coding to complete the analysis. The first round was spent interpreting the students' maps and filling out the student generated propositions worksheets as best we could, identifying any obviously qualitative propositions as we progressed. The second coding round was completed after we had organized the propositions on the worksheets into categories to help us come up with a list of concept words to assist us in our coding. The final product composite map was a representation of our researcher words and concept list constructed during the analysis process that best represented the themed ideas expressed by the students. It depicted the percentages of student groups' maps in which we saw each idea expressed. While this shows that the SMART method is technically adaptable to concept mapping assignments without common concept lists, from my experience throughout these studies, this was a cumbersome and tedious way to analyze these maps.

Chapter 5: Background and Methods for Case Study

In this Chapter I'm going to provide the reader with the background and context needed to understand this case study within the context of the professions of emergency medical services and emergency medical services education. Then I will discuss the methodology of this case study in more specific detail.

Overview of Emergency Medical Services

Emergency medical services are organizations that provide medical care to patients outside of hospitals and traditional healthcare settings. This medical care is typically intended for emergencies requiring immediate medical care, or where a patient needs assistance reaching medical services due to an acutely disabling condition. Across most of the United States of America, emergency medical services (EMS) are notified of an emergency when a citizen calls an emergency number, usually 911, to request emergency medical care. This 911 call for help leads to the prompt dispatch of an ambulance to the location of the emergency. Sometimes depending upon the local jurisdiction and the needs of the residents, additional EMS practitioners may also respond to the location of the emergency from the local fire or police department.

There are four levels of EMS practitioners in the United States of America. In order from the narrowest scope of practice to the broadest: 1) Emergency Medical Responder (previously known as a First Responder), 2) Emergency Medical Technician, 3) Advanced Emergency Medical Technician, and 4) Paramedic. Ambulances must be staffed with a minimum of two EMS practitioners, at least one

of whom is trained to the Emergency Medical Technician level. An ambulance that

meets this minimum standard can provide basic emergency medical care, which is

referred to as basic life support (BLS). An ambulance that is staffed by at least one

paramedic can provide the highest level of emergency medical care, which is called,

advanced life support (ALS). Almost all firefighters and police officers, as well as

others who provide emergency medical care prior to the arrival of an ambulance, are

trained to the Emergency Medical Responder level. Despite the widespread and

critical role of EMS, the development of today's modern EMS system occurred

within recent history.

History of Emergency Medical Services

Emergency medical services (EMS) in the United States of America can trace

roots back to the wartime evacuation of wounded soldiers from battlefields during the

Civil War[4]. From the Civil War up until the early 1960s, EMS consisted of haphazard

services provided by hospitals, fire departments, or morticians (Shah, 2006). Mostly,

an ambulance driver responded to the scene of an emergency then rushed the injured

or ill patient to the hospital. Little if any medical care was provided for the patients

before arrival at the hospital. Modern EMS did not really begin until the late 1960s

and early 1970s (Rockwood el al., 1976).

In the early 1960s public attention was focused on major health problems such

as cancer, heart disease, stroke, and trauma. Both Presidents Kennedy and Johnson

focused attention on these public health threats (Shah, 2006). The National Academy

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[4] Outside the United States of America, the earliest EMS system is credited to
Napoleon's physician Jean Dominique Larrey (Shah, 2006.)

of Sciences and National Research Council published a groundbreaking paper in 1966 highlighting the plague of accidental death and disability in the United States. "Accidental Death and Disability: The Neglected Disease of Modern Society" called for the development of EMS systems and a network of trauma hospitals to receive critically injured patients (NAS/NRC, 1966). The same year this pivotal paper was published, Congress passed the Highway Safety Act. One stipulation of the Highway Safety Act of 1966 was that states were required to establish EMS systems or lose up to 10% of their federal money for constructing highways. These two pivotal events in 1966 are traditionally credited with commencing the development of modern EMS systems (Ponzer et al., 2004; Rockwood et al., 1976).

History of Emergency Medical Services Education

Despite the obvious critical nature of EMS in our society, the profession is a relatively new healthcare field when compared to long-standing medical professions such as allopathic medicine and nursing (King, 2000; Michael, 2001). Since the start of modern EMS systems in the late 1960s, EMS education has been trying to keep pace with the rapidly developing EMS profession.

In the late 1960s and early 1970s there was a rapid development and organization of EMS education to meet the needs of the new EMS systems. The first EMT textbook and curricula were published in 1967 and 1971 respectively. The American Academy of Orthopedic Surgeons "Emergency Care and Transportation of the Sick and Injured" was the first EMT textbook. This textbook was based on the course AAOS had been conducting for ambulance attendants (NHTSA, 2000). Shortly after, in 1971, the first EMT curriculum, EMT-Ambulance, was developed by

a contractor for the National Highway Traffic Safety Administration (NHTSA, 2000). Soon all fifty states adopted the NHTSA 81-hour EMT course or its equivalent training standard (Rockwood el at., 1976). This is in stark contrast to the pre-1966 era when only 48% of ambulance workers were trained to the equivalent of the advanced Red Cross first aid level and many had no medical training at all. Soon adequate training for EMS practitioners would become a mandated responsibility of EMS systems.

In 1973, the Emergency Medical Services Systems Act mandated that EMS systems provide appropriate training for EMS practitioners to include clinical experiences and continuing education (Gibson, 1977). Not long after this, two new levels of EMS practitioner training were introduced: First Responder and Paramedic. In the early 1970s NHTSA developed a 40-hour curriculum called "Crash Injury Management for the Law Enforcement Officer." This curriculum evolved into First Responder in 1979, which equates with today's Emergency Medical Responder curriculum. The American Medical Association officially recognized Paramedic as an Allied Health Profession in 1975. Shortly following this, the first Paramedic curriculum was published by NHTSA in 1977 (NHTSA, 2000). In essentially a decade, the foundation of today's EMS education system rapidly took shape. Unfortunately this led to the development of an EMS education system where it was difficult to revise the national curricula while taking into account the differing needs of local EMS systems from across the country. This system of top-down national EMS curricula with periodic content updates continued without question into the early 1990s. As a profession, there was a constant battle between trying to maintain

national curricula while still allowing for local diversity. There was a need for EMS personnel to be trained and ready to work across the country, yet depending on the locale their training may have very unique components (eg. wilderness medicine).

The first organized national EMS education plan was published in 1993 as the "National EMS Education and Practice Blueprint" (NREMT, 1993). This document had the effect of getting stakeholders talking at all levels about the need for an organized EMS education system at the national level. These conversations set the stage for the design and implementation of the current EMS education system during the 2000s. The "EMS Education Agenda for the Future: A Systems Approach" was published in 2000 outlining a vision for a national EMS education system that was no longer dependent on top-down curricula, but instead flexible to the varying needs of local jurisdictions.

National EMS Education System

The "EMS Education Agenda for the Future: A Systems Approach" outlines a national EMS education system consisting of five core components: 1) core content, 2) scope of practice model, 3) EMS education standards, 4) education program accreditation, and 5) certification (NHTSA, 2000). The main intent of this system was to prescribe at the national level a minimum standard of core content and educational standards that are required at the national level, but not to prescribe the curricula through which to teach to these standards. Throughout the late 2000s, the first three components of the EMS education system were outlined in more detail with the publication of the National EMS Core Content (NHTSA, 2005), National EMS Scope of Practice Model (NHTSA, 2007), and the National EMS Education Standards

(NHTSA, 2009). The remaining two core components were achieved through independent agencies. The National Registry of Emergency Medical Technicians (NREMT) serves as the national certification board for EMS (NREMT, 2014). The national accreditation board for paramedic programs is the Committee on Accreditation of Education Programs for the Emergency Medical Services Professionals. Effective January 1, 2013 candidates wishing to take the national paramedic certification exam must have attended an accredited paramedic program (CoAEMSP, 2014). Our nation's EMS education system is still taking shape before our eyes and is relatively young in comparison to other more established health professions. This logically has had an effect on the EMS education literature.

EMS Education Literature

As I have just outlined, EMS within the United States is a relatively new medical profession and as such, the educational system for EMS is still taking shape. Unsurprisingly, this means that the EMS education literature is relatively sparse in comparison to allopathic medicine or nursing education literature. There is a call for EMS education research of a wide variety of types.

In a Google Scholar search in November 2014, with the terms "emergency medical services education," on the first page of search results, there was only one article that could be categorized as EMS education research and it is the eighth out of ten on the screen. When I repeated this same Google Scholar search in June 2015, I found no articles that could be categorized as EMS education research. Most of the articles were EMS clinical research.

There is no dedicated journal for EMS education. In fact, the official journal of the National Association of EMS Educators is also the official journal of the National Association of State EMS Officials (Informa Healthcare, 2014). Prehospital Emergency Care is the journal where the majority of EMS education literature is published along with a large proportion of the clinical and systems EMS research.

For this literature review of EMS education, I searched in Google Scholar using the phrases "emergency medical services education" and "EMS education" until I reached saturation. In order for articles to be included, they had to be primarily about the education of EMS practitioners and involve research conducted in the United States. Articles that researched already outdated material (eg. previous national standards) were excluded. To ensure that my Google Scholar search had not missed any articles, I then searched within the journals Prehospital Emergency Care and Prehospital and Disaster Medicine for any articles on the subject "education." These two journals were chosen because the majority of the articles were published in one of these two journals. This strategy only produced a few more articles.

A total of 104 EMS education articles were selected for review in February 2015 (See Appendix E). 89 or 86% of these articles researched systems level problems. Research about EMS educational systems asks questions about the education of EMS providers at the organizational level. Such questions may simply attempt to describe the characteristics of EMS educational systems or may study the effect of an intervention on the system.

Much of this literature (32 or 36%) is survey-based and focuses on describing specific characteristics within EMS education systems. One of the earliest such

studies by Grubbs (1997) surveyed accredited paramedic programs across the nation about students' access to patients for clinical skills practice.

A publication from the Longitudinal Emergency Medical Technician Attributes Demographic Study (LEADS) Project by Dawson et al. (2003) describes the national state of EMS education. The LEADS survey was sent to randomly stratified samples of nationally registered EMTs and paramedics. It asked questions about their initial training, continuing education, instructor's characteristics, and confidence in practice based on education (Dawson et al., 2003).

In 2005, Ruple et al. in partnership with the National Association of EMS Educators conducted a survey of a random sample of EMS educators. The EMS educators were asked questions about their backgrounds, workplaces, resources available when teaching, and comfort levels teaching (Ruple et al., 2005). These types of large-scale survey research are very necessary given the history of how EMS systems and their corresponding educational systems developed in diverse ways throughout the United States. But this research is also, only scratching the surface in terms of the power of educational research and it inevitably raises many more questions than it answers.

In addition to the scarcity of EMS education literature, the variety of topics studied in the EMS education literature is also limited. The most common topics researched include: advanced airway maneuvers (11 or 11%), disaster medicine (11 or 11%), pediatric populations (11 or 11%), simulation (11 or 11%), cardiovascular and stroke medicine (7 or 7%), death notification (5 or 5%), and geriatric populations (4 or 4%). Another popular topic is attempting to look for correlations between

educational system features, or student factors, and students' certification exam scores (16 or 15%). When combined, these topics account for 76 or 73% of the total articles reviewed.

One common model of EMS education research is to study the effect that an educational intervention, such as a new curriculum, will have upon a defined component within an EMS system (38 or 37%). Seamon et al. (1997) designed a 45-minute videotape based training to help address EMS practitioners' lack of knowledge about how to recognize and address elder abuse. The training was well received by EMS providers and appeared, based on pre and post-tests, to improve their awareness and knowledge of the topic (Seamon et al., 1997).

Another commonly recognized problem in EMS is the degradation of skills when not frequently performed in the clinical setting. One such skill is endotracheal intubation, which while it can be life-saving in terms of protecting a patient's airway, is rarely performed by individual paramedics. Lubin & Carter (2009) conducted a study in which critical care paramedics practiced their endotracheal intubation skills on manikins on a daily basis. They found that this did not improve the paramedics' intubation success rates on actual patients and over time compliance with the demands of the study declined (Lubin & Carter, 2009).

A much more recent problem within EMS is the growing number of systems that are adopting termination of resuscitation protocols, causing providers to have to deliver the notification of death on a much more routine basis. Most EMS providers have received little if any training on how to effectively notify loved ones about a death. Hobgood et al. (2013) designed a training curriculum to prepare EMS

practitioners to deliver death notifications. When studied by assessing pre- and post-training case-based role-play scenarios, the EMS providers improved in confidence and competency (Hobgood et al., 2013). While well designed studies like the ones just reviewed are necessary and powerful, and will shape the future of EMS education, I argue that a key component of EMS education systems is almost completely ignored in EMS education research: pedagogy.

In this literature search I identified 8 (8%) articles that researched pedagogical questions. Pedagogical research examines questions about how content is taught. Much of the EMS education literature asks very simple questions about how the material is taught such as: who should teach, and what method to use to teach. Crocco et al. (2003) examined the effects of a physician versus an Advanced Cardiac Life Support certified instructor teaching case scenarios about stroke. They found that in post tests there were no differences between the two instructors when using the new case scenarios to teach about stroke and that both were effective in comparison to pre-tests (Crocco et al., 2003).

Hobbs et al. (1998) evaluated the effects of the same instructor teaching three classes using different teaching methods. One class was taught using traditional classroom instruction, the second via synchronous instruction over personal computers on the internet, and the third via a satellite into a classroom. The authors found no differences on students' exam scores or course attrition rates during the study (Hobbs et al., 1998).

De Lorenzo and Abbott (2004) designed a randomized controlled study to test adult learning pedagogies on soldiers enrolled in the U.S. Army's Combat Medic

School. Randomly selected instructors were trained for two weeks in how to teach

with a "small-group interactive approach, self-directed study, multimedia didactics,

and intensive integrated practice of psychomotor skills" (De Lorenzo & Abbott, 2004,

p. 33). These instructional strategies were instead of the traditional large enrollment

lecture with disconnected skills labs. Over the 10-week course they found only a

modest improvement in students' exam scores with the treatment group (De Lorenzo

& Abbott, 2004). While this is a sound randomized controlled experiment, I find that

this is a classic example of what is wrong with EMS educational research. It does not

make any sense to expect that a 2-week course on teaching pedagogies followed by

being "thrown to the wolves" is going to dramatically alter an instructor's well-

established pedagogical methods. As science professional development literature has

documented, actual pedagogical change that can be expected to have lasting impacts

on student learning takes serious personal reflection, mentoring and opportunities for

growth in a supportive environment (Rosebery & Puttick, 1998; Stofflett, 1994; and

van Driel et al., 1998).

The National EMS Research Agenda outlines a need for EMS educational

research that evaluates "both the content of EMS curricula adequacy and the

effectiveness of teaching techniques" (NHTSA, 2001). In an attempt to just broach

the surface of this call for action, I will study a paramedic instructor applying the

SMART method to her students' concept maps.

Methods

The overarching purpose of this case study is to examine how an instructor

uses the SMART method to analyze her students' concept maps. More specifically, it

focuses on how the instructor's beliefs affect her use of the tool, and how her use of the tool in turn refines her beliefs. I previously described the development and use of the SMART method on an immunology cohort and two paramedic cohorts in Chapter 3. The two paramedic cohorts were taught by the same course instructor, Angel. In this chapter, I will describe a case study examining Angel learning to use the SMART method to analyze her students' concept maps. This research was approved by the University of Maryland Institutional Review Board (10-0619).

Participant Selection

Angel was chosen for participation in this research because of her intense interest in EMS education research and her willingness to openly and candidly discuss her thoughts with me. This purposeful selection of Angel was based upon the methodology of Patton (1999). Patton (1999) describes how "purposeful sampling involves studying information-rich cases in depth and detail (p.1197). In building this case study of Angel, I drew upon the methodology of Yin (2003). Angel is a unique case (as described by Yin, 2003) in that she is an experienced EMS educator who is currently pursuing her doctorate in education. In particular, I hoped that Angel's expertise and research interests in EMS education would help her to articulate more clearly her thinking while using the SMART method in comparison to the average EMS instructor. Having an articulate and candid participant is especially helpful in an exploratory case study where a topic is studied for the first time.

Layering as Participant Co-Researchers

The portions of the study in which I acted as the researcher and Angel was the participant included design of the case study and analysis of the interview data. The portions of this study that were conducted as participant co-researchers included the design and analysis of concept mapping assignments. The role of Angel as a participant and my role as a researcher blended at times during this study into the role of participant co-researchers (Heron & Reason, 1997). This decision was made because both Angel and I were studying for our doctorates in education and had extensive experience as EMS practitioners. Angel brought to the research her many years of experience as an EMS educator whereas I was a relatively new EMS educator. I brought to the research my several years of experience working with the SMART method in depth. Angel was familiar with the general idea behind concept mapping and already had a concept mapping assignment in her paramedic course; however, she had never tried analyzing her students' concept maps. Due to Angel's role as a participant co-researcher, and my desire to give her due credit for helping to conduct portions of this research, Angel agreed to the use of her real name.

Concept Map Assessment Design

Working together as a team of participant co-researchers, Angel and I discussed and chose the best course topics for a concept map assignment. Not every topic taught within an EMS program readily lends itself to either the hierarchical or network style linking of concepts as is depicted in a concept map. For instance, EMS ethics does not readily lend itself to a concept map. Instruction of EMS ethics is best enhanced through other techniques, like case studies from the field, that emphasize

98

the struggles of individual decision-making that are inherent in ethical dilemmas. However some EMS topics by their very nature consist of concepts that are highly connected and well suited for depiction in a concept map. For example, shock is a topic that EMS practitioners must understand thoroughly, and the process of drawing a concept map can potentially help a student to see the interconnectedness of the concepts within shock. Additionally, Angel's perception of topics students traditionally struggled with also weighed into the decision for which paramedic course topics to create concept mapping assignments. We hoped that the concept mapping assignment for these traditionally difficult topics would serve as another activity to assist students in learning the content. The concept map topics from the first paramedic cohort were Autonomic Nervous System and Diabetes. The concept map topics from the second paramedic cohort were Autonomic Nervous System, Respiratory Medicines, and Shock.

Together Angel and I constructed the instructor's expected concept map based on the instructional objectives and lesson plans for each topic. It's important to note that the instructor's expected map is not what we actually "expected" all of the student's to draw, but what we hoped they would draw based on the learning objectives. From each instructor's expected concept map, we extracted a list of concept words to assign to the students to include in their concept map.[5] The design of these concept mapping assignments paralleled the design of the original

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[5] In the respiratory medicines concept map assignment, the students were not provided with the names of each respiratory medicine from the instructor's expected map, but instead were instructed to include the medicines that had been discussed in class on their maps.

immunology cohort concept mapping assignments from which the SMART method was designed.

Concept Map Assignments

The paramedic students completed the assigned concept maps as part of their coursework. In the past Angel had assigned her paramedic students concept mapping assignments, so she also wanted these assignments as part of their regular coursework. The concept mapping assignments Angel gave in the past were less structured and usually consisted of her students constructing concept maps in small groups on large chart paper. For our research, the list of concept words derived from each instructor's expected concept map was alphabetized and turned into a concept mapping assignment. The size of the list ranged in size from 9 to 15 concept words with a median of 13 concept words. The students were tasked with constructing their own concept maps from the concept word list provided for each concept mapping assignment. Please see Appendix F for the paramedic students' concept mapping assignments.

Prior to the first concept map assignment in each cohort, the students were briefly shown how to construct a concept map and examples of concept maps. All of the students were taught how to use Cmap Tools software (Institute for Human and Machine Cognition) and part of their assignment was to construct the concept map using the CMap Tools software. The software is fairly intuitive and easy to use even without instruction on its use. The only trouble spot I've noticed students encountering with the software is the directionality or lack of, for the propositional arrows (See Appendix D).

Concept Map Analysis

Angel and I worked side by side as I taught her how to use the SMART method to analyze the students' concept maps. This way Angel could ask questions and voice her comments about the SMART method as we were applying it to her students' maps. This setup allowed me to gain insight into Angel's thought processes as they were occurring, so I could probe in the moment, not later during an interview. And as I spontaneously thought of questions whether clarification or curiosity in nature, I asked Angel.

As Angel became more proficient using the SMART method, we worked together as a team to analyze the students' concept maps. I continued to create as welcoming of an environment as I could for Angel to share her thoughts about the SMART method, and her thoughts as she analyzed her students' concept maps. As questions came to my mind during this process, I continued to ask them to stimulate our discussion. And just as frequently as I started a discussion, Angel spontaneously began talking about something on her mind. In fact, a large portion of the transcribed data comes from "interesting moments" when Angel initiated the conversation.

Data Sources

The entire time Angel and I worked together on this project our conversations were audio recorded (See Table 9). This allowed me to capture Angel's reactions to the SMART method and her thoughts while analyzing her students' concept maps as she was experiencing them. Mixed in throughout our conversation about the tasks we were performing, I asked Angel questions as the conversation triggered particular lines of thinking. Due to the manner in which I conducted our work sessions, they can

best be categorized as active unstructured interviews of Angel (Fontana & Frey, 1994; Holstein & Gubrium, 2004). It's important to remember that Angel and I were conducting very structured analyses of her students' concept maps during these interviews, but our actual conversations about the analyses and "meta" thoughts about the analyses were completely unscripted and spontaneous. Additional data sources include all of the materials associated with analyzing the students' concept maps with the SMART method. These include: analyzed student concept maps, analysis worksheets, and marked up instructor expected concept maps. Mostly these data sources were used to help clarify and confirm the audio recordings.

Data Analysis

To analyze the data I have collected for the case study on Angel, I listened to the audio recordings and time stamped notations describing "interesting moments" in the conversation. Most of the time stamped "interesting moments" I notated fall into one of two categories: 1) theoretical discussions about the analysis decisions involved when using the SMART method or 2) meta discussions about the unfolding or completed SMART analysis. The audio recordings are active unstructured interviews, so spaced in between the notations of "interesting moments" are recordings of silence, the technical details of analyzing the concept maps, and off-topic discussions (e.g. personal conversations). As I notated all of the audio recordings, I kept a list of emerging themes. My process of documenting emerging themes drew upon open coding (Strauss & Corbin, 1998). These "interesting moments" were then transcribed as described below.

Transcription of Interview Tapes

The notated sections of the interview tapes were transcribed with an attempt to
capture the entire duration of the conversation unit containing the "interesting
moment" that was originally time stamped. Sometimes this meant capturing

Table 9. List of Audio Tapes by Date, Topic, and Length

Date	Topic	Length
Paramedic Cohort 1		
9/26	Autonomic Nervous System Analysis Part 1	2 hr 45 min
9/28	Autonomic Nervous System Analysis Part 2	1 hr 15 min
10/8	Autonomic Nervous System Analysis Part 3	1 hr 30 min
1/19	Diabetes Planning	1 hr 3 min
5/25	Diabetes Analysis Part 1	0 hr 33 min
5/25	Diabetes Analysis Part 2	2 hr 15 min
5/25	Diabetes Analysis Part 3	0 hr 33 min
Paramedic Cohort 2		
8/30	Year Two Planning	1 hr 2 min
10/4	Respiratory Medicines Planning	2 hr 31 min
10/10	Shock Planning	1 hr 28 min
12/6	Autonomic Nervous System Analysis Part 1	0 hr 51 min
12/11	Autonomic Nervous System Analysis Part 2	2 hr 30 min
12/11	Respiratory Medicines Analysis Part 1	0 hr 30 min
12/18	Respiratory Medicines Analysis Part 2	3 hr 3 min
12/27	Shock Analysis	3 hr 30 min

conversation before the "interesting moment," sometimes after, and sometimes on both ends. This was done in an attempt to capture understandable segments of transcript that were not isolated from the context in which they occurred.

Anytime there was a large gap of time (greater than 30 minutes) between notated sections of an interview tape, I went back through the tape listening to approximately 10 to 15 seconds of the conversation every minute. This was a check to ensure that during the original notation process, I had not become distracted and stopped actively listening to the tapes. On the Respiratory Analysis Part 2 interview tape, I identified three additional "interesting moments" to notate and transcribe. Two of these were actually identified during the process of attempting to capture the entirety of the conversation for a following segment. However one segment would have been missed had I not performed this check on the large non-annotated segments of the tape. It's possible, even likely, that there are additional "interesting moments" hiding within the interview tapes that I did not find. But given the amount of evidence I will present for my main themes, supported by multiple quotes and aligning with each other, it is unlikely that any one missing "interesting moment" would significantly change the story.

As the notated interview recordings were transcribed, the transcript segments were sorted by emerging theme. Again this process of sorting the transcript segments based upon themes that emerged from the data drew upon open coding (Strauss & Corbin, 1998). My day-to-day work during the transcription process consisted of producing the transcripts for each "interesting moment" with annotations reflecting my thoughts about how this segment fit into the story that was emerging. At least

once a week during this process, I spoke with my advisor, Dr. Andy Elby, and we walked through each transcript segment and discussed its utility to the developing story. This process sometimes led to refinements of how I was interpreting the transcript segments. As the transcriptions and discussions were ongoing, I was simultaneously building two documents with the transcript segments. One document contained all of the transcribed "interesting moments" and my annotated thoughts about them in chronological order. The second document was started a little bit into the process and was used to sort the transcript segments by how they fit into the emerging themes. Some transcript segments could be used to document multiple emerging themes, and so they appeared in this emerging document multiple times.

The themes that emerged were: 1) SMART testimonial, 2) instructor map missing proposition, 3) black versus white, 4) SMART reveals curricula changes, 5) misconception, 6) novice versus expert, and 7) Angel thinking about novices. The SMART testimonial category was for any transcript segment that raved about the SMART method or generally referred to advantages of the SMART method. The instructor map missing proposition category was for instances during the SMART analysis when Angel noticed that she would like to add a new proposition to her instructor's expected map. The black vs. white theme had to do with Angel referring to something in terms of absolutes, as opposed to a hard to navigate shades of gray. The SMART reveals curricula category was for examples of Angel discussing ways in which she would like to change EMS curricula. The misconception theme was for times when we were discussing students' ideas from the perspective that the student was harboring an error in their thinking. The novice vs. expert theme was by far the

105

most predominant, and referred to times when we were referring to the students as exhibiting novice traits, which I will discuss more in the next section. The Angel thinking about novices' category was for segments where Angel was revealing more details about her thoughts surrounding novice learners. These transcript segments in their entirety as originally sorted appear in Appendix G.

Shaping of Emerging Story

Looking at the themes that emerged from the data, the dominant theme was Angel having a novice vs. expert perspective. In an attempt to characterize the way Angel views her students through this novice perspective, I compiled a list of the key descriptive words from transcript segments that were coded novice vs. expert. Then I organized this list of descriptive words so that similar descriptive words were grouped together. Once all of the descriptive words were grouped, each group was described to more clearly define the distinct aspects of Angel's novice perspective. These aspects included: 1) beginner characteristics, 2) difficulty with comprehension, 3) flawed or incomplete, 4) extraneous unnecessary information, 5) not the norm, and 6) more in depth than expected.

Member Checking

In order to attempt to validate my interpretations of the interview data, I conducted member checking with Angel. After a first draft of Chapter 6 was written, I asked Angel to read it before we met for one final interview. Angel in her enthusiasm and interest in my research, read the slightly over 200-page draft of my dissertation in which Chapter 6 was embedded. Going into this interview, I had just two questions

for Angel: 1) Are there places where the way I portrayed your views not quite

capturing what you think? and 2) Where does your novice / expert perspective come

from? Below is Angel's response to the first question.

> Angel: No I think it's fine, I actually was umm felt very connected to what
> you had written and felt like you had umm done a good job in being
> insightful and umm I don't, there isn't anything that I read that you
> attribute to me where I thought no she doesn't get my point or she
> doesn't understand what I'm saying. Not one single place. And there
> wasn't any place where it felt like the conversation you and I had was
> not a conversation that we had. So it all felt very genuine and that you
> were right on track.
> Laura: Okay, excellent!
> Angel: I felt complimented by some of the things that you said.
> Laura: Oh, that's nice!
> Angel: Yeah

I am inclined to take Angel's words here as her true sentiment because before

the interview began she was very frank with me about one item of feedback after

reading the dissertation. She asked me if I had intended to be so repetitive in my use

of some of the transcript segments. I informed her that yes, in some places I did use

the same segment of the transcript to make multiple points. As for the second

question I had for Angel about where her novice / expert perspective comes from,

below is her answer.

> Angel: Umm it's come about several times for me umm I remember
> specifically this was not the first exposure, but I remember specifically
> being in a meeting down in DC, it was a federal level meeting and it
> involved education and the training of EMS providers and that was a
> big topic that we had in that meeting because they were concerned
> about a gap that they were perceiving. And someone brought out umm
> during the conversation that might be one of the things that was
> attributing to where the gap was from and it just seemed very
> insightful. Umm another I do remember too umm when I wrote the
> critical thinking chapter for my paramedic book I was doing research
> then, that was back in 2007-2008. And I was looking at the way
> novices and experts, the way people learn how to critically think. And

I did encounter quite a bit of it there and saw a lot of research but most of the research I saw was directed at how the nursing literature.

Laura: Okay

Angel: Uh as far as healthcare related and then the rest of it was in being an educator for all these years its just, it has come up on a few different occasions at workshops or conferences, NAEMSE conferences, things like that, JEMS conferences whatever that I'm just, anytime I see that as a theme, I'm just very much interested in it. So I'll, so I can't exactly pinpoint where...

Laura: Okay

Angel: It's just been kind of a recurring thread.

Laura: Okay, all along...

Angel: Yeah

Based upon Angel's sentiment here that the novice / expert literature resonates with her and has been a recurring theme in her professional experience; I can see how it became a major focus during this research as well. I too have been drawn to the novice / expert literature in my encounters with it, so perhaps the combination of both of our biases influenced in some way the prevalence of the novice / expert theme in this case study.

Interrater Reliability

In an attempt to establish the reliability of my interpretations of the interview data, I evaluated the interrater reliability with a fellow science education researcher, Sabrina Kramer. For the purposes of the interrater reliability, I trained the rater in my use of the novice / expert, misconception, and black / white codes. The other codes were not included in the interrater reliability because they did not identify Angel's thinking about students' learning and were not major contributors to the arguments of the case study. For a more detailed look at the document I used to train the rater and the exact codes that the rater gave each transcript segment, please refer to Appendix H.

For a summary of the interrater reliability results, please see Table 10. The

rater showed a strong alignment with my coding for the novice / expert code. Out of

ten instances where I applied the code, the rater also applied the code. In one instance

though the rater also applied the misconception code, which I did not, but looking at

the excerpt again, I agree with her coding. For the two transcript segments where I

had applied the misconception code, the rater also applied the misconception code,

but in both cases she went beyond and applied a secondary code. In one of these cases

I agreed with the application of the secondary code, but not in the other.

For the four transcript segments that I coded black and white, the rater initially

was not coding these as black and white, but instead as novice / expert. On the third

Table 10. Summary of Interrater Reliability. Code Key: Novice / Expert (NE), Misconception (M), Black and White (BW).

Agreement	Number	Notes
Complete	9	8 NE; 1 BW
Partial	3	Laura: M and agrees with BW; Sabrina: M & NE Laura: NE and agrees with M; Sabrina: NE & M Laura: M and sees BW, but thinks too minor Sabrina: M & BW
Disagree	3	3 Laura: BW; Sabrina: NE; 3rd NE code Sabrina chose because Angel is talking about patients and not student thinking, so it can't be BW.
Control	1	Laura: Instructor Map Missing Proposition Sabrina: Doesn't Make Sense, Not Like the Others

one she explained her reasoning that she considered the black and white code but

decided against it because in the segment Angel was talking about patients, not

student thinking. After this segment, the rater correctly coded one transcript segment

as black and white. In retrospect thinking about this, I realize now I inadvertently

gave the rater the idea that the black and white code applies to student thinking when

in fact it's the only code she was working with that didn't apply to student thinking and I can see how this was confusing to her.

There was also one transcript segment included in the interrater reliability that had a code different from the three included in the interrater analysis. This was done intentionally to make sure the rater wasn't just randomly assigning codes to the transcript segments. I had coded the extra transcript segment as instructor map missing proposition. The rater noticed that it "doesn't make sense, it's not like the others" and was struggling to assign a code to it.

Chapter 6: Case Study of Paramedic Instructor Utilizing SMART Method

This is a case study of a paramedic instructor utilizing the SMART method to analyze their student's concept maps. As a reminder, the research question for this second study is: How do a paramedic instructor's beliefs about students and learning affect – and become affected by – her use of the SMART method as a formative assessment tool? I will argue that the instructor's beliefs about students and learning affect her use of the tool, which in turn refines her beliefs. I am going to problematize simplistic accounts of tool use where the tool is simply assimilated into prior beliefs. I will also challenge simplistic research designs that focus only on the extent to which an instructor's use of a tool matches the intent and epistemology of the tool designer.

I will show how Angel is a constructivist teacher who views her students as novices. Her view of novices is not limited to lacking the knowledge of experts, but focuses on how they think in fundamentally different ways from experts. One of these ways is how novices tend to view medical decisions as black or white, instead of the nuanced judgment calls that are really shades of gray. She views learning as a sense-making process and even struggles with the dilemma of how much to help her students in their sense-making journeys. I will argue that these beliefs drive Angel to go to great lengths to use the SMART method to help her understand how her novice students are conceptualizing ideas in their concept maps. And I will show how this very process, driven by Angel's beliefs, is also refining these beliefs. By taking the time to really explore her students' concept maps, not only are Angel's beliefs

refined, but she also takes the time to reflect on, and question, the structure of EMS education more broadly.

Angel's Complex View of her Students as Novices

Angel's view of her students as novices is rather complex and multi-dimensional. She doesn't simply view the students as lacking the knowledge of an expert, but as fundamentally thinking differently from an expert. She also acknowledges that students are not simply the opposite of novices, but that they fit somewhere on the continuum from novices to experts and at any given moment may occupy a different place along that continuum.

Angel's view of novices differs from the novice / expert literature in that she doesn't just view the novice students' ideas as focusing on superficial structures (Chi et al, 1981), but also capable of depth. She also views her students' ideas as expressed in their concept maps as potentially useful building blocks for deeper more complex thinking like a constructivist. This is not something in line with the novice / expert literature, which at best is agnostic about this idea.

Now I'll walk you through the process of how I built this picture of Angel viewing her students as novices. Some of the evidence is very straight forward, some is easy to interpret, and some must be interpreted a bit more. It is very straight forward that Angel is viewing her students as novices when she comes right out and says, "And you know this is obviously a novice pattern of thinking." It is fairly easy to interpret that Angel is envisioning her students as novices when she makes comments like, "...because we're content experts now and we've mastered it and so we sort of forget those struggles that we go through."

It is a bit more difficult to interpret that Angel is talking about her students as novices when she says: "So they phrased things oddly. And they kind of went different directions from me and the thought processes but they had a lot of correct things to say." But the interpretation gets easier to make when a picture emerges that Angel's description here is not an isolated case. The above quote is from the analysis of the respiratory medicines concept maps and there is another very similar quote appearing in the analysis of the cohort 1 autonomic nervous system concept maps. "Well I just don't think of it in those terms. That's all. It's not an untrue statement...what they're...but why it's weird or quirky...is because those terms are synonymous. Adrenergic and sympathetic are synonymous. That's where the use of the statement is a little twisted." In both of these quotes I argue that Angel is comparing herself (the expert) to the students (novices) and saying that the students' work is different from how she thinks about the material.

When considering the overall picture and totality of evidence, I argue that there are a multitude of statements like these statements that can also be interpreted as Angel viewing her students as novices. From my analysis, a picture emerged in which Angel's view of her students as novices is actually rather complex and multi-dimensional. Six different aspects of Angel's novice view were identified during this case study. The aspects are: 1) beginner characteristics, 2) difficulty with comprehension, 3) flawed or incomplete, 4) extraneous unnecessary information, 5) not the norm, and 6) more in depth than expected.

Another theme that is closely related to these aspects of Angel's view of novices is the black vs. white theme. I am going to discuss this theme in more detail

113

separately, later on in this chapter, for two reasons: 1) because it is subtly different from the themes here as it does not solely relate to student thinking, but instead expands into instructor thinking as well and 2) because it has very important implications for EMS education.

Beginner Characteristics

One of the ways in which Angel views her students as novices is by attributing beginner characteristics such as naïve, simplistic, superficial, linear, and absolute to her students. Angel attributes these beginner's characteristics to the student's ideas as expressed on their concept maps in lieu of describing their ideas as incorrect. During the analysis of a student's diabetes concept map she described one of their propositions as "superficial" and "naïve." Here Angel is using these words to describe how the student is thinking about the cause of diabetes from a novice perspective.

> Laura: "Blood glucose exceeding the normal limits will cause diabetes."
> Angel: High blood glucose levels lead to diabetes. Superficial. It is very
> superficial. The high blood glucose level doesn't cause diabetes.
> Laura: No, so the cause in there makes it incorrect.
> Angel: That's what I'm saying, it's...
> Laura: Yeah
> Angel: It's a naive statement.
> Laura: Yeah, if you interpret it totally correctly they are totally literally the
> cause makes it incorrect.
> Angel: Right
> Laura: That cause in there makes it incorrect.
> Angel: They are not seeing cause and effect and they are not seeing that in
> several of their statements.
> Laura: So you want to make this an "M?"
> Angel: And it's an incorrect statement.
> Laura: Okay, umm.

Notice, not only is Angel using the words, "superficial" and "naïve" to describe the student's proposition, but she is hesitant to label the proposition as incorrect. I describe the student's proposition as incorrect three times before Angel is willing to agree that, in fact, what this novice student has stated can actually be categorized as incorrect. By that point in the conversation, her incorrect categorization was likely for the purposes of following the procedure of the SMART method, not because that was her initial impression of the student's proposition.

Angel also attributes beginner's characteristics to her students' concept maps before she jumps to the conclusion that the students didn't put a lot of effort into the assignment. When analyzing a student's respiratory medicines concept map, Angel described the student's map as "linear" and "simplistic."

> Angel: Very linear.
> …
> Angel: Yeah, but this one yeah it's very simplistic.
> Laura: Mmmyeah
> Angel: Everything, there was basically two levels here. Everything coming into bronchodilation they just had the classes.
> Laura: Mmmhmm
> Angel: And then they just gave you a couple examples of each of them, but this one they decided to talk about the bronchial smooth muscle relaxation. And this one just gave you the subclasses.
> Laura: Mmmhmm
> Angel: So and then this effects that receptor and it's a mineral. And I mean this is very much a one trick pony do it in five minutes.
> Laura: Yeah
> Angel: To turn it in for a grade map versus a conscious thinking of the relationships and you know...
> Laura: Yeah
> Angel: ...doing some depth analysis.

Angel goes on to decide that not only is this student exhibiting the beginner's characteristics of a novice, but that in her opinion this student also didn't spend a lot of time thinking about the relationships in their concept map. This is important

because she is blaming this student's "bad" answer on their effort and not on their lack of knowledge or ability to do better. This also brings up an interesting catch-22 for novice learners. A novice won't truly understand the importance of why they need to understand something in depth until they have already learned that topic in depth and now understand why it is so important.

Difficulty with Comprehension

Angel has several different ways of stating that her novice students are having difficulty comprehending a concept. Some of the specific words and phrases in her statements include: doesn't make sense, struggle, and jumbled.

During the analysis of the Cohort 1 Autonomic Nervous System concept maps, Angel revealed some of her thoughts about novices and experts.

> Angel: ...which is an expert from a novice. Is that novices or experts lose the ability to think like a novice.
> Laura: Yeah.
> Angel: I've actually heard that, you know, quite a bit. And you know this is obviously a novice pattern of thinking.
> Laura: Yeah.
> Angel: And if, and I look at it and you even look at it and although this is, this is, you're connecting this to other knowledge you already have you're looking at this going it doesn't make sense.
> Laura: Yeah.
> Angel: And I'm looking at it going it doesn't make sense. But obviously to them it made perfect sense or they wouldn't have coded it and put it on paper. And that's to them, that's a logical relationship.

Here she is expressing how novice ideas don't always make sense to experts, but as experts it's important to remember that a novice wouldn't have expressed that idea if it didn't make sense to them. Later during the analysis of these maps, she explains how she makes an effort to focus on trying to think like a novice.

> Angel: Cause then that will kind of tell me and my thinking, cause I do often

116

wonder about and I've been, I've been at a couple different meetings
and things where that whole concept of we cease to be able to think
like a novice.

Laura: Yeah.

Angel: And so I've kinda sorta refocused on that the last couple of years. Like
how do they think about these concepts. And why is it so...

Laura: A struggle.

Angel: Well why is it something that is so blatantly obvious to us is such a big
struggle for them, and I think if, I think one of the keys in helping, I
don't know.

Angel describes how she intentionally tries to understand why it is so easy for
experts to understand and think about concepts, yet novices struggle so much with
seemingly simple ideas. Later during the analysis of the diabetes concept maps, Angel
goes on to expand upon this idea of students struggling to understand concepts.

Angel: ...because we're content experts now and we've mastered it and so we
sort of forget those struggles that we go through. But I said one thing
that this project has done to help me with is going back and analyzing
the students' this allows me to analyze the students' thought
processes in a way I haven't been able to do before. And it really gives
me a lot of insight because sometimes when they answer test
questions and I walk away from that I think why did they pick that
answer, that's ridiculous, you know.

Laura: Yeah

Angel describes how analyzing the students concept maps with the SMART
method allows her to better understand the struggles that her students go through
trying to understand the content in the course. She goes on to explain how this even
helps her see how the students come to answers that she normally sees as ridiculous.
Angel then continues to expand upon this idea by explaining how she can even see
how the students develop incorrect answers as part of their novice learning struggles.

117

Flawed or Incomplete

Angel attributes students flawed or incomplete ideas to them being novices.

Some of the words she uses to describe these ideas include: wrong, flawed, and

incomplete. Following from Angel's explanation above of how students' novice

learning struggles can lead to ridiculous answers, she then goes on to explain how she

understands how students can arrive at incorrect answers.

> Angel: There's no way that answer is the correct answer, but then when I see
> their thinking processes illustrated here in the way they've shown me
> how they've made the connections, I can go back and go oh, now I see,
> even though it's still flawed and wrong.
> Laura: Yeah.
> Angel: I can actually sort of see the path...
> Laura: Uh huh
> Angel: ...that they took to get to that wrong answer a little bit clearer. And it
> kind of helps me realize that I make assumptions that there
> con...making connections of logic that they're really not.
> Laura: Mmm hmm

When Angel describes how she can now understand how students arrive at

incorrect answers, it is one of the rare moments when she is actually framing their

answers as incorrect. Besides "playing the game" of the SMART method to

categorize student generated propositions as correct versus incorrect, Angel rarely

takes a stance framing students answers as incorrect. She is much more likely to use a

term such as jumbled to characterize a student's thinking or one of the many other

terms she uses to describe her students as novices.

> Angel: See I don't even know what the connection is here. Cause it...man this
> is really jumbl..., it's really not...I'm gonna run to the restroom...
> Laura: [laughter]
> Angel: ...think on it. You can think on it while I'm gone...
> Laura: Okay
> Angel: ...cause it's very jumbled thinking. And it's kind of all over the place.

118

Notice how Angel thinks that it's important to spend time deciphering the students' ideas even though she considers them jumbled. This means she still thinks that they can be understood despite their flawed nature.

Extraneous Unnecessary Information

Angel views the addition of extraneous and unnecessary information in the students' concept maps as a novice trait. She uses such terms as: redundant, irrelevant, and sidebar. During the analysis of the Cohort 1 autonomic nervous system concept maps, Angel describes a student's proposition as irrelevant and a sidebar.

> Angel: It's given to patients. And it is antiadrenergic. But again this is, this whole thing is, this whole thing is irrelevant, is another sidebar.
> Laura: Mmm.
> Angel: And...
> Laura: Maybe they were...
> Angel: This...
> Laura: ...searching for something there.
> Angel: Well this is a sidebar, but it is one that they will be required to learn. And obviously...[unintelligible]

Interestingly though, Angel goes on to acknowledge that despite the fact that this student's proposition is off topic for this map, that they will be required to learn this bit of information later in the class. At another point during the analysis of these same concept maps, Angel described a student's proposition as redundant.

> Angel: …But what's interesting here though is...this statement here "adrenergic medication can also exhibit sympatholytic effect."
> Laura: Mmmhmm
> Angel: Would be like saying capital A is the same as lowercase a, I mean it's a, it's a, what type of a statement is that? The relationship...
> Laura: Redundant.
> Angel: Yes. Yes.
> Laura: Mmmhmm.
> Angel: It's redundant.
> Laura: But it's...
> Angel: Now this though is good, but this is...what they're saying is adrenergic

119

effects, you know, that these are the effects... but this is very good that it's beyond the scope of what we were asking them to do."

Not only is Angel acknowledging that this seemingly redundant line of reasoning made by the student is novice, she is also noticing that by thinking along this line the student is attempting to expand their thoughts beyond the scope of what was taught in class. This is in contrast to a similar idea in which Angel describes students ideas as being different or outside of the normal.

Outside the Norm

Another way in which Angel views her students as novices is through her classification of some of their ideas as differing from the norm. She describes these ideas using words such as: odd, quirky, twisted, slang, strange, and different. In the analysis of the first cohort's autonomic nervous system concept maps, Angel uses several of these terms to describe how a student is portraying the content differently from how Angel would.

Angel: It's just an odd, it's quirky, but okay. Here.
Laura: Huh.
Angel: It's similar to what they did. But they said "adrenergic..."
Laura: "Adrenergic medications can also exhibit sympatholytic effects."
Angel: Huh...It's not untrue.
Laura: [Laughter]
Angel: I just don't...
Laura: This stuff is complicated.
Angel: Well I just don't think of it in those terms. That's all. It's not an untrue statement...what they're...but why it's weird or quirky...is because those terms are synonymous. Adrenergic and sympathetic are synonymous. That's where the use of the statement is a little twisted.

Angel is not trying to characterize this novice's ideas as incorrect, but simply different from how she herself, as an expert, would conceptualize this topic. Again,

120

during the analysis of the respiratory medicines concept maps, Angel says something very similar about a student's concept map.

> Angel: So they phrased things oddly. And they kind of went different directions from me and the thought processes but they had a lot of correct things to say.
> Laura: Okay

Another way in which Angel expressed that the students were thinking differently from her also occurred during the analysis of the first cohort's autonomic nervous system maps. In this example Angel describes the students' different language as slang.

> Angel: Wow! So much about feeding and breeding here!
> Laura: [laughter] People's favorite activities.
> Angel: Well and it was, but it was slang. That's what's so strange about it. It's just a slangy... You know but it shows you the power of mnemonics, I guess. See we had it as a memory tool: fight or flight.
> Laura: Yeah.

Here Angel is struck by the students' frequent use of the memory tool "feed and breed." She considers it to be just a memory tool, designates it as slang, and is surprised by how frequently the students are including it in their concept maps. In contrast to this idea that the students' ideas are diverging from Angel's is the notion that the students are digging deeper than expected and moving along the novice-expert continuum towards expert.

More in Depth than Expected

Angel understands that students' ideas fall on a continuum from novice to expert. She recognizes that at times her novice students will express more complex ideas than she is expecting. She has described these ideas with the terms deeper and beyond. During the analysis of the cohort 1 autonomic nervous system concept maps,

Angel noted in several ways how the students were going more in depth than she

expected.

> Angel: And...where is it now, "adrenergic...sympatholytic..." I think they took it one step beyond. I think they went one step beyond.
> Laura: Really?!
> …
> Angel: Right. Right. And it's actually much deeper than I intended to...when we constructed the map, we just did the nervous thing, so it's actually a lot deeper than where we meant to go.
> …
> Angel: Now this though is good, but this is...what they're saying is adrenergic effects, you know, that these are the effects... but this is very good that it's beyond the scope of what we were asking them to do."
> Laura: Well, let's catalog them, cause they appear to all be student generated.
> Angel: Okay.

As you can see Angel doesn't just view her students on the far end of the

spectrum close to novice; she also views them at times making progress along the

continuum towards expert lines of reasoning.

In summary, Angel has a fairly complex view of her students as novices.

Angel's view of her students as novices can be categorized into six themes: 1)

beginner characteristics, 2) difficulty with comprehension, 3) flawed or incomplete,

4) extraneous unnecessary information, 5) not the norm, and 6) more in depth than

expected. The evidence outlined above represents examples from the totality of

evidence as documented in Appendix G.

One could argue that the SMART method by its very nature of comparing the

instructor's predicted map to the students' maps sets up the tone for a novice versus

expert perspective. I will argue later that Angel does not actually view herself as the

ultimate expert or authority during the SMART analysis of her students' concept

maps and even learns from the process. This complex picture of Angel viewing her

students as novices isn't an isolated anomaly but instead is part of the larger picture of Angel as a constructivist teacher. Relating back to the research question, Angel's view of her student's as novices begins to paint a picture of Angel's beliefs about her student's. This picture of Angel's beliefs about her students will become clearer as I next explain how Angel is a constructivist educator.

Angel as a Constructivist Teacher

Angel is a constructivist teacher[6] because she views learning as a sense-making process. She doesn't think students learn simply by absorbing what they are told and shown. Angel views the process of learning as a struggle to understand and make sense out of all of the new ideas and concepts students are taught. I will show how Angel's focus on this sense-making aspect of learning is constructivist in nature.

In the classic Piagetian or Vygotskian definition of constructivism, Angel is concerned with understanding how learners construct their knowledge. While both Piaget and Vygotsky conceptualize "constructivism" very differently, they would both agree that learners construct new knowledge in ways that involves their old knowledge (Phillips, 1995). I will show how she struggles with the dilemma of how much to help her students in their sense-making journeys. Then later I will explore how Angel uses the SMART method as a tool to help her really understand the ideas her students' depicted in their concept maps.

Angel spontaneously discussed one of the dilemmas of constructivist teaching she wrestles with during the analysis of her students' concept maps. The first time she

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[6] While constructivism is a theory about learning, not a teaching style, I am usin constructivist teaching here in a way consistent with much of the science education literature.

mentioned it occurred during the analysis of the first cohort's autonomic nervous

system maps. Angel described how there is a benefit to allowing the students to

struggle some to arrive at discovering their own answers. She likened it to allowing a

chick to hatch without assistance, or a butterfly to emerge on its own.

> Angel: It's like you know like when you're watching a chick hatch. Have you ever done that? Actually seen one really hatch? If you grow up on a farm your parents will tell you very quickly you don't help them out of the egg shell because if you actually get in there and pick and help them emerge out of the egg.
> Laura: Mmmhmm
> Angel: A lot of times they'll die.
> Laura: Why?
> Angel: It's there's something that's going on physiologically in the act of breaking out...
> Laura: Uh huh
> Angel: That you know it's kind of like a butterfly when it, when it comes out, its that struggle to get out is what gets the circulation going and it gets their wings expanding and then they can fly.
> Laura: Uh huh
> Angel: And if you ever would get in to a chrysalis and like you see one emerging and you want to help it a little bit the wings won't expand and they won't fly, they won't be able to fly. It's like it kills them, the act of the struggle is actually what allows them to become what they're gonna be. And so some of this I don't know if it's really appropriate for us to help them make connections always. Sometimes its like you have to let them struggle through that and sort of encourage that they're on the right track without actually correcting their errors. And then let them kind of come to their own understanding in the end.
> Laura: Hmm
> Angel: And that's what I find fascinating about education really is trying to find out what that right mix is, not so much that you, it frustrates them to quit, but its enough for them to stay engaged in them wanting to know instead of you handing it to them.
> Laura: Yeah
> Angel: So
> Laura: I didn't know this
> Angel: Yeah
> Laura: The chicks and the butterflies...
> Angel: Yeah, yup it'll kill them.
> Laura: Hmm
> Angel: It's very interesting, yeah it's something about the struggle that makes

them what they are. Pretty cool, huh?
[laughter]

Angel describes how she is fascinated by the challenge of trying to strike the

correct balance of allowing students to learn from their struggles, but not challenging

them so much that they lose interest. Two weeks later, as we continued analyzing the

first cohort's autonomic nervous system concept maps, Angel talked again about how

she struggles with this particular dilemma.

> Angel: I'm just always kind of torn, I go back and forth a lot between actually sitting down and connecting the dots for them...
> Laura: Mmmhmm
> Angel: ...or having them dig and this level, at this level of learner...
> Laura: Mmmhmm
> Angel: ...I find them to be very dependent although this class has not been very argumentative...
> Laura: Mmmhmm
> Angel: ...about things. But I find them to be very dependent of, they sort of want me to connect dots for them instead of them connecting themselves. So they don't come in and engage me in questions about well gosh I read this and I didn't quite understand what it meant, you know my big thing is, well did you know and of course they're not gonna be honest about this, but raise your hand if you read the chapter. You know.
> Laura: Yeah
> Angel: And that's kind of, and then they'll passively although they do get engaged but they'll relatively fairly passively sit in class. I can do application pieces afterward which I've been trying to do and I do more of where we'll sort of I'll talk about a topic and then we'll immediately apply it. But a lot of and they will discuss it and they will enjoy doing those kind of things, but a lot of the things are they haven't laid a good foundation yet.
> Laura: Mmmhmm
> Angel: So they're not really getting all of the stuff out of that they would had they laid a foundation before they walked in the door. So then I have to just hope and trust that then they go home and they read the chapter.
> Laura: Okay
> Angel: But when they go home they go, well I've already got everything I need, I don't need to read the chapter now.
> Laura: Mmm
> Angel: And then I move on into the next phase of the class.

Angel describes of the delicate balance of allowing students to struggle through the process of making sense of the material, yet helping them with the process just enough so they are not frustrated and discouraged. I argue that this dilemma Angel describes is a typical dilemma constructivist educators face. It's an example of the overlap of pedagogical and cultural dilemmas described by Windschitl (2002). It's a pedagogical dilemma in the sense that Angel struggles to create learning activities that allow students to productively make their own sense. But it is also a cultural dilemma in the sense that Angel has to balance that desire with the need to prevent the students from getting frustrated. She realizes that too much independent learning without the assistance of their teacher is counterproductive.

When these constructivist dilemmas are taken into account with Angel's complex view of her students as novices, the picture begins to form of Angel as a constructivist educator. It's important to note that there are limitations to this portrait of Angel, as it's based on interviews and not observations of her actual teaching. But it's also important to keep in mind that if these "constructivist" ideas are revealed while she is utilizing the SMART method, but not consistently in her teaching, that the SMART method is helping her tap into productive instructional resources.

In regards to the research question; I have described Angel's beliefs about students. I will next describe how these belief's affect her use of the tool and how her beliefs are refined during this process. Specifically, in the next sections, I will show how Angel takes a perspective that she can learn from her students and the analysis of their work, so she devotes a lot of time to the SMART method and trying to understand her students concept maps.

126

During the analysis of the students' concept maps, Angel takes a perspective that she can learn from the process of conducting the SMART analysis on her students' concept maps. Angel views this as her "own personal teaching improvement project." She is learning more about her students' thinking but also has the opportunity to reflect on ways to improve EMS education. Not only is she attempting to learn from the concepts the students found salient to depict in their maps, but also more specifically she is learning from what they chose to depict that she did not. A recurring theme throughout the SMART analysis was Angel having these "ah ha" moments in which she realized that she would like to revise her instructor's expected concept map to include additional ideas that she suddenly found salient or that the students found salient to include. Below I will discuss some of the episodes in which Angel realized that she would like to add some new ideas to her instructor's expected concept map.

In our very first analysis session, while Angel was learning how to analyze the first cohort's autonomic nervous system concept maps, she noticed some ideas that she wanted to add to her map. She even expressed hope that the students would find it salient to include these ideas in their maps.

> Angel: Yeah there's something else kind of missing out of there too.
> Laura: What?
> Angel: Parasympatholytic and Parasympathomimetic are opposite effects.
> Laura: Oh, so maybe the students will catch that.
> Angel: Yeah, and the same thing here Sympathomimetic and Sympatholytic are opposite effects.
> Laura: See we noticed lots of things like this when we went through the immunology thing.
> Angel: Yeah
> Laura: Like these are continually, these maps are continually improving.

127

Angel: Wow.

This observation of Angel's was not a surprise to me. The immunology instructor I had worked with when developing the SMART method had also wanted to revise his instructor's expected maps on multiple occasions. Later during the analysis of the diabetes concept maps, Angel initially thinks that a student's proposition also appears on her map, but it doesn't. She realizes this is problematic and wants to add it to her map.

> Laura: "Hypertension also increases risk of peripheral vascular disease."
> Angel: That's on here, I think. Maybe we didn't make that connection.
> Laura: There is no link on the map between hypertension and PVD.
> Angel: We have neuropathy and hypertension, diabetes uncontrolled.
> Laura: Nah, there's no link between hypertension and PVD.
> Angel: Yeah, there should be. Huh.
> Laura: But there's not.
> Angel: You know I thought about that too when I was coding the map just
>   now.
> Laura: [laughter] So that's a "G."

One of the ideas that Angel realizes was absent from the instructor's predicted map is surprising to her. In fact it's a very salient idea and I'm also amazed that we overlooked it when constructing the map.

> Angel: That is so weird that we didn't make any connection between
>   blood pressure and shock [laughter] that's just weird.
> Laura: [laughter]
> Angel: Umm, so we have that in there somewhere cause one of the students
>   said it. Shock uh blood pressure and...uh lower...
> Laura: Shock is directly related to blood pressure or more specific...
> Angel: Well shock BP lowers blood pressure.
> Laura: Low BP is a late sign of shock.
> Angel: No, low blood pressure equals shock basically is what this says.
> Laura: All we have is low BP is a late sign is shock.
> Angel: Okay, well then this is a new one.
> Laura: Okay

This serves as a classic example of what I mean by salience having moment of time context dependence. In the moment and context in which Angel and I collaboratively constructed the shock instructor's predicted map, neither of us felt it salient to include a link between shock and blood pressure. Looking at the map now in retrospect, that is mind-blowing as blood pressure is fundamentally and intricately related to shock. But this just goes to show how it's possible for any given assessment to only capture a portion of a person's understanding of a topic at any moment in that given context.

As an educator, Angel is aware that this "in the moment contextual nature" of assessments can affect what students find salient to include on their maps. She thinks that perhaps her students could have been generally clued to include more ideas on these maps if prompted differently in the instructions for the task.

> Angel: I think it's interesting to see where they are weak, like this idea of these being branches of each other.
> Laura: Mmmhmm
> Angel: But they, but some of them I guess this represents maybe three or two students.
> Laura: It's two.
> Angel: Two, recognized that it's also known as.
> Laura: Mmmhmm
> Angel: So they are seeing the relationship its just that when we ask them to express it, it wasn't easily coming out.
> Laura: Yeah
> Angel: Now I didn't clue them in to umm making connections but I have a feeling if I would have pushed them and suggested like when we counted it up we saw that at least two things connected to each thing.
> Laura: Mmmhmm.
> Angel: I think if we would have expressed to them umm that each of these concepts will have at least two connections.
> Laura: Mmmhmm
> Angel: That might have framed it for them and kind of given them a little push to dig a little deeper. Because I think a lot of those maps were the example of umm...
> Laura: Not...

Angel: ...superficial effort as a secondary thing.

This ability of Angel to learn from her students and reflect on her own role in the assessment process is another piece of her as a constructivist educator. Angel does not view herself as the ultimate expert in contrast to her students as only novices. She can learn from them and she does. Angel is not the final authority and she is not approaching the analysis of their concept maps from the perspective that any differences between her instructor predicted map and their maps is a deficit of the students'. She enters the SMART analysis of her students' maps with an open mind, bringing along her novice versus expert and constructivist mindset that help shape her use of the tool. One of the ways in which Angel's beliefs about learning and epistemological perspective shaped her use of the SMART analysis tool is by driving her to carefully interpret her students' maps in an attempt to really understand their meaning.

Angel Carefully Interprets Students' Concept Maps

Angel spends a lot of time and energy trying to understand her students' ideas. This is going to be a fairly straightforward and easy argument to make, but I am also going to propose that she does this because she views her students as novices and has an underlying constructivist perspective. The causation in this second argument is impossible to definitively establish, but I will point out evidence hinting at it.

Throughout the analysis of the students' concept maps there are multiple examples where Angel went to great lengths to really try to understand what a student was expressing with their concept map. She did this even when she felt that the students' map was incorrect, different, off-topic, or demonstrated little effort on

behalf of the student. In these instances she could have simply coded the map, attributed a negative belief to it if it was unsatisfactory, and moved on. But instead, Angel chose to dig deeper and spend time trying to make sense out of these students' concept maps to really try and understand their novice perspective better through her expert learner lens.

In this first example during the analysis of the first cohort's autonomic nervous system concept maps, Angel is struck that the students maps are using a lot of slang but she stills continues to dig deeper and analyze the exact meaning.

> Angel: Wow! So much about feeding and breeding here!
> Laura: [laughter] People's favorite activities.
> Angel: Well and it was, but it was slang. That's what's so strange about it. It's just a slangy... You know but it shows you the power of mnemonics, I guess. See we had it as a memory tool: fight or flight.
> Laura: Yeah.
> Angel: But not causes, fight or flight stimulates parasympathomimetic or sympathomimetic but not sympathetic. We don't have that statement as you're saying it. We have the purpose as an overgeneralization. We have controls. I think, does that sound pretty good? SNS controls fight or flight? Causes? What do you think?
> Laura: No cause it's "parasympathomimetic causes feed or breed."
> Angel: Right and then "sympathetic causes fight or flight," right?
> Laura: No, "sympathomimetic causes fight or flight." And then we have "fight or flight is the result of sympathetic." So we do have that: "fight or flight is the result of sympathetic."
> Angel: Okay, SNS controls fight or flight, that's "S".
> Laura: Okay and then...
> Angel: PNS controls feed or breed, that's "V".
> Laura: Okay
> Angel: Okay, now what else?

It's possible that Angel is only digging deep and trying to analyze this in depth because she is "playing the game" of the SMART method. Even if that is the case, by doing so she is gaining a sophisticated and deeper appreciation for her

students' perspective, which includes in her mind the use of slangy memory tool

mnemonics.

During the analysis of the diabetes concept maps, Angel explicitly states how

the analysis of the concept maps using the SMART method helps her to better

understand her students' novice thought processes. She was talking with faculty

members at a meeting discussing how she was working with me on this research

project and how it was helping her to better think through the students' novice

perspective instead of her expert one.

> Angel: Umm, but I was talking with the faculty members one of the things
> that I mentioned to them that this process has done for me is I said
> you know any of us that have been teaching for ten years or fifteen
> years or twenty years sometimes the students and maybe even other
> educators will tell us that we've lost the ability to think like a novice
> and to recognize what a novice is going through...
> Laura: Mmm hmm
> Angel: ...because we're content experts now and we've mastered it and so we
> sort of forget those struggles that we go through. But I said one thing
> that this project has done to help me with is going back and analyzing
> the students' this allows me to analyze the students' thought
> processes in a way I haven't been able to do before. And it really gives
> me a lot of insight because sometimes when they answer test
> questions and I walk away from that I think why did they pick that
> answer, that's ridiculous, you know.
> Laura: Yeah
> Angel: There's no way that answer is the correct answer, but then when I see
> their thinking processes illustrated here in the way they've shown me
> how they've made the connections, I can go back and go oh, now I,
> even though it's still flawed and wrong.
> Laura: Yeah.
> Angel: I can actually sort of see the path...
> Laura: Uh huh
> Angel: ...that they took to get to that wrong answer a little bit clearer. And it
> kind of helps me realize that I make assumptions that there
> con...making connections of logic that they're really not.
> Laura: Mmm hmm
> Angel: And so this has really helped, this you know analyzing that previous
> map and I'm sure with this one too it'll help me see how these are
> really complicated processes and its not an easy thing for them to get

this the first pass. And that we need to keep trying to create ways that they can continue to manipulate this.

I argue that Angel's thoughts and beliefs about how this research is benefitting her, as expressed by her above, influence the amount of time and energy she spends analyzing students' concept maps even when they seem completely wrong or nonsense to her.

While we were analyzing the respiratory medicines concept maps, Angel declared that a student's proposition is nonsense. Despite making this negative initial judgment about the student's work, she continued to examine it in-depth in an attempt to fully understand exactly what the student meant.

> Angel: Okay, this is a nonsense. "Bronchial smooth muscles causes bronchodilator." These this, all of these terms refer to the class of drugs, so bronchodilator is correct. This is a nonsense statement. So is that just "I" and its wrong?
>
> Laura: Uh, I think...I think they're in a very maybe perhaps they're saying in a very roundabout way that relaxation of the...
>
> Angel: They already did that.
>
> Laura: ...bronchial smooth muscles causes bronchodilation. [Unintelligible]
>
> Angel: Well here the term is a drug.
>
> Laura: Yeah
>
> Angel: Bronchodilators cause bronchial smooth muscle what?
>
> Laura: If you think it doesn't make any sense, yeah, I see what you're saying how they already said it relaxes it.
>
> Angel: Yeah they already talked about that stuff, so I think that's just a nonsense so and the direction of the arrow its "bronchial smooth muscles causes bronchodilator" and that's a nonsense statement.
>
> Laura: Maybe if you read the whole thing together, "beta-2 agonist relaxes bronchial smooth muscles causes bronchodilator."
>
> Angel: But they meant bronchodilation. I'm sure.
>
> Laura: Yeah
>
> Angel: But they're talking about the drug class there.
>
> Laura: Yeah
>
> Angel: So then that makes all the rest of these wrong if you read that as...
>
> Laura: Yeah
>
> Angel: And a lot of these are right.
>
> Laura: Yeah
>
> Angel: So I think they just made a stupid connection.

Laura: Okay
Angel: So bronchial smooth muscles so that's an "I"
Laura: Mmm hmm
Angel: Bronchial smooth muscles causes and underline causes bronchodilator and that's incorrect. And it'll probably only show up once, but...

Again you can make the argument that Angel might only be playing the game of the SMART method here, but even if that's the case (which I don't think it is), it turns out to be very productive. In trying to understand this student's one nonsense proposition, she ends up analyzing in depth the student's entire concept map. She is trying to decide if the student mistakenly thought they were connecting the proposition to the word "bronchodilation" instead of "bronchodilator" which would make the statement make sense. But then several of the student's other propositions would no longer make sense if the word were changed. Angel finally decides that the student made this proposition without realizing that the concept word was "bronchodilator" not "bronchodilation."

Later during the analysis of the respiratory medicines concept maps, Angel encounters another nonsense proposition that she also picks apart.

Angel: "Beta-2 agonist if it binds to multiple sites is non-specific beta-agonist." It's that's a non-sense statement. Beta-2s are specific, non-specific betas are not beta-2s, so...
Laura: I think they're saying there that a beta, a non-specific beta agonist is...oh yeah that doesn't make any sense.
Angel: Unless they're trying to say that...
Laura: ...that it's related to a beta-2...
Angel: ...if it's, it's either, I don't know if they're saying it's an either or statement...
Laura: Maybe
[microwave popcorn & strawberry interlude]
Angel: "Beta-2 agonist non-specific if it binds to multiple sites its called non-specific," but beta-2 agonists are not non-specific. So that's why this is difficult. Beta-2 agonists bind to beta-2 sites.
Laura: Mmmhmm

Angel: Non-specific beta agonists could have cardiac or respiratory cause
they could be beta-1 or beta-2 binding.
Laura: Yeah
Angel: So is it an "AA?"
Laura: I don't, I mean sure.
Angel: Okay. And it's incorrect. It's partially correct, it's close, but it's not.
Had they made it two statements they probably would have had it
right.
Laura: So it's beta-2 agonist...
Angel: Mmmhmm
Laura: And then where do you want the middle to be?
Angel: If it binds to multiple sites...and that should be underlined. Non-
specific beta agonist.

Here there is no doubt, Angel's priority is to make sense out of the student's

proposition in the context of their map. She makes a special effort to find out what

may be partially correct in the student's statement, even though it initially appears

nonsensical to her. Then only after she's sure she understands it, she attempts to

assign a code to it for the purposes of the SMART analysis. Angel's actions here are

clearly consistent with a constructivist stance because the student's ideas are viewed

as different from an experts', but not necessarily lacking in substance.

As a reminder the research question for this case study was: How do a

paramedic instructor's beliefs about students and learning affect – and become

affected by – her use of the SMART method as a formative assessment tool? To

answer the first part, I described Angel as a constructivist educator, who views her

students as novices. I argued this drives her to take the position that she can learn

from their thought processes as she is interpreting their concept maps with the

SMART method, so she really takes the time to carefully interpret their maps. She

really wants to understand their novice perspective in contrast to her expert one so she

doesn't stop trying to understand her students' ideas when she could simply dismiss

them as incorrect. Someone who didn't have these beliefs wouldn't necessarily learn as much from the SMART method. The SMART method also provides Angel a way in which to apply her constructivist beliefs, which yields valuable information about students' ideas. This in turn has the effect of reinforcing Angel's constructivist and novice / expert perspectives. This revision of Angel's beliefs that I describe is the answer to the second half of the research question.

In this case Angel's constructivist beliefs about learning have a synergistic effect on her use of the SMART tool to understand her students as novice learners. Angel already has the preexisting beliefs that drive her to take the time to truly understand her students' ideas and the SMART tool helps instructors to understand their students' ideas as expressed through concept maps. When Angel's beliefs are combined with the SMART tool, the potential of the SMART tool as a formative assessment is enhanced. Throughout Angel's use of the SMART tool in this research study, not only did she learn about her students' ideas from their novice perspective, but also some important themes emerged with implications for emergency medical services (EMS) education.

Implications for Emergency Medical Services Education

Throughout the case study of Angel using the SMART method to analyze her students' concept maps, two common themes emerged about how EMS education can be improved. The first theme focuses on how EMS curricula need to be revised to allow time to revisit topics that are identified as problematic during formative assessments. The second theme addresses the need for educators to promote critical

thinking in their students, as opposed to defining the world of patient care in absolutes.

Curricular Revisions

As I highlighted in the EMS education literature review, EMS is rapidly changing and EMS educators are struggling to revise curricula to keep up with the rapid pace of the changes. One of the main problems this leads to is the curricula becoming tightly packed with little room to go back and revisit a topic without cutting out time allotted to teach a different skill set. And in the field of EMS, it is very easy to make an argument that everything that is taught in the curricula is vital to saving lives and therefore necessary.

Angel spontaneously discussed this particular problem with EMS education on two occasions while we were working together to analyze her students' concept maps. On the first occasion, during the analysis of the cohort 1 autonomic nervous systems maps, she acknowledges that utilizing the SMART method enhanced her awareness of how badly she needed to revisit topics and how problematic it is that the curricula have no room for doing so.

>Angel: Well I mean you've already given me a great deal of awareness in umm it this is really a battle of throwing stuff and throwing stuff and throwing stuff and seeing how much sticks.
>Laura: Mmmhmm
>Angel: Right. And not a whole lot stuck. It actually a little bit less stuck then what I thought would have stuck. And we don't have a lot of time for reinforcing. Mmmhmm and although we do build.
>Laura: Yeah.
>Angel: We don't have a lot of time to go back and like I would not necessarily have time in the program unless I made time and sacrificed something else to walk into the classroom and say okay guys based on this map we didn't really get it, let's do the lecture again. Now I don't know how helpful that would be anyway. But I don't have time to do that, so now

I just have to make sure that as I move forward I keep reinforcing these things and I do as I build on final exams I do tend to bring a 10 to 20 percent previous content...

Laura: Mmmhmm

Angel: ...into the comprehensive exam at the end for each class.

Laura: Yeah.

Angel: So I might pick one or two questions out of here to put on the test again just to kind of remind them that maybe in the past I wouldn't have done that.

Laura: Uh huh.

Angel: I would have picked other things with other topics assuming they pretty much had nailed this. But apparently they didn't.

Angel explains how the content builds on prior content, so there is scaffolding of concepts built into the curriculum, but not a means to address a situation where students are struggling to understand one of the foundational concepts. Later in our analysis of the diabetes concept maps Angel discusses this exact problem.

Angel: And that's, I think that's a flaw of ALS instruction and EMT instruction in general in that we sort of we one time topic and then we move on to the next one time topic and then we move on to the next one time topic and we don't really necessarily pull it all together and make connections and help them make connections.

Laura: Mmm hmm

Angel: We just sort of assume that they're doing that as they go along.

Laura: Yeah

Angel: And even when we look at a single topic, we're seeing they're not doing that.

Laura: Yeah, yeah

Unfortunately, because the curriculum is continuously building and dependent on students' having learned the previous content, if a student struggles with a concept early in the program, they are set up for failure because the curriculum doesn't have the space to allow for a student to explore the concept further and in different contexts until they truly understand it.

One classic example of this phenomenon from my teaching is when emergency medical technician students struggle with learning when and how to

138

oxygenate and ventilate patients. This is one of the first major concepts in patient care that the students are taught at the beginning of the semester. It will be a recurring theme in every other unit of learning as they are progressively asked to assess more complicated patients and think more critically about how to treat their injuries and illnesses. One of the first items they must assess and address with every patient they care for is making sure that they have adequate oxygenation and ventilation. This must be mastered early so that the students can focus on learning the much more complicated concepts later in the class. But students frequently struggle with this concept and sometimes are still wrestling with it at the end of an EMT program, instead of focusing on understanding the critical concepts being taught such as what's likely wrong with this patient and what's the best course of treatment. This speaks to the teaching of critical thinking in the EMS classroom. Frequently students struggle with the concepts that are not black and white, but gray and require complex thinking.

Critical Thinking

Another theme that emerged during the case study with Angel involved novice learners and their desire to define problems in absolutes (black vs. white) as opposed to the shades of gray that normally characterize the world of patient care. Angel discusses how EMS educators, in their effort to help students learn complicated concepts, will sometimes oversimplify them into absolutes, which even further hampers the development of students' critical thinking abilities. She criticizes "how EMS you know…wants to teach absolutes and wants to put everything in a nice little box for everybody…."

139

Angel explains how she wants to teach her students how to critically think

about decompensated shock using patient case scenarios. She wants to help them

realize that shock is complicated and will appear as shades of gray in the real world.

     Angel: So that'll be something to emphasize. And I kind of like to do that with
          some scenario things.
     Laura: Mmm
     Angel: Like here's some vital signs and make them vague...
     Laura: Okay
     Angel: ...in some cases, make them obvious in others. But make some of them
          vague so they actually have to declare what they think it is.
     Laura: Okay
     Angel: You know cause the patient's aren't always completely black and
          white, it's those shades of gray. And I think that that'll help drive home
          the idea that decompensation is the transitional stage.
     Laura: Yeah
     Angel: And you've got the compensated who can fairly easily recover with the
          right support.
     Laura: Yeah
     Angel: And then you've got the irreversible, which are not going to recover
          despite whatever support you're giving them. And then you've got that
          huge valley in between that is the transitioning between the two.
     Laura: Yeah
     Angel: And that's what some of them aren't grasping is you've got this danger
          zone that if you're in it early enough you might be able to save them,
          but if you're at it too late. And I think that's why that whole concept...

Angel explains how critical it is for students to understand the subtleties of

shock because there is a fine line between being able to intervene and save a patient's

life and it being too late because the patient is already experiencing cellular death and

irreversible organ damage. Angel goes on to explain how novice learners sometimes

try to oversimplify trends when they are taught to be mindful and watch for particular

patterns and trends in patients.

     Angel: So and I think that some of them maybe get fixated because we do talk
          about and it says a lot in the book actually about if you've got a patient
          on beta blockers because you want to try, we sort of want to drive the
          students away from thinking in terms of absolutes.
     Laura: Okay

Angel: But there are some trends that they need to recognize.
Laura: Okay
Angel: And I think that that's where they don't make the subtle
difference is in recognizing a trend.

Angel then goes on to explain how this oversimplification can lead to an

incomplete understanding of the concept, which can lead to life threatening decisions

about how to care for the patient. Instead of recognizing the severity of the situation,

a student with an incomplete understanding of the concept of shock is less likely to

treat aggressively in the early stages, and thus prevent progression into more

profound and deadly shock.

Angel: Yeah we definitely need to talk more about pulse pressure. I think
they're getting basics though. It's really hard to talk about...the vital
signs because again you can simplify it and put them in absolutes but
that's not the presentation they're going to get and that's why it's they
really have to think through what the presentation is and kind of
critically think...
Laura: Uh huh
Angel: ...and in some cases when you're in that decompensated zone you
really, they really need to make not that it should affect their treatment,
they should be aggressive. And that was one of the things I had to tell
these guys because a couple of the umm priorities that they would give
me is they would articulate with the scenario that the patient was in
decompensated shock but then would assign them a priority of three.
And it's like you guys aren't getting that everybody in shock really
needs to be a one. They're not gonna die at this moment in time but
they still need to be aggressively cared for. And so they were missing
that whole and we talked about that one day that they were missing
that whole you know cause it they're just so used to seeing these signs
and symptoms that then they're not really applying it properly. So...

Angel took the time to explain her thoughts about novices seeking absolutes

and how EMS educators need to help them understand the real shades of gray in the

world of patient care during the analysis of the shock maps. But this was not the first

time she had brought up the idea of novices thinking in terms of absolutes. Angel also

mentioned it during the analysis of the diabetes concept maps.

Angel: See this person is, really is talking in absolutes. You know what I
mean?
Laura: Yeah.
Angel: Major risk, most common...
Laura: Yeah, they're getting very specific.
Angel: Yeah

What Angel was focusing on here was how the student was applying

qualifying adverbs to their propositional linking words that eliminated the gray that

exists in the complicated picture of how diabetes develops in many patients. In this

particular case, the effects were minor in comparison to the shock example, but she

was still able to pick up the trend that novices try to oversimplify concepts.

In summary, Angel highlights the need for instructors to encourage students'

critical thinking by not over-simplifying EMS content into black or white when the

reality is really a complex decision requiring gray. This idea fits hand in hand with

her statements about how EMS curricula need more time. If there isn't even time

currently for instructors to review concepts, then it's easy to see why instructors are

tempted to simplify concepts into black or white instead of taking the time to discuss

how to navigate making complex decisions about the gray world of patient care.

While these two implications for EMS education are likely not novel ideas to Angel,

the SMART method has the effect of allowing Angel to take the time to reflect on her

students' ideas and her teaching, and allows these themes to come to the forefront of

her thinking.

Discussion of Case Study

Angel is an expert paramedic instructor, who has a fairly complex view of her

students as novice learners. This view is part of Angel's constructivist perspective in

which she views learning as a sense-making process. This perspective also extends to Angel learning from her students and from performing the SMART analysis itself. Angel's beliefs about learning drive her to invest time in really trying to understand her students' concept maps as she performs the SMART analysis. During the research, Angel highlights the need for EMS education to change in two important ways: 1) create more time in EMS curricula to revisit topics and 2) encourage students to learn how to critically think their way through making decisions about the gray world of patient care. Angel's reflections on these important implications for EMS education are likely going to shape her beliefs as an instructor.

It is likely that Angel's constructivist beliefs about novices and her use of the SMART tool are being refined and influenced by each other. Angel's beliefs about novices drive her to spend a lot of time using the SMART tool to really try and understand her students' ideas. This deep, thorough and informative use of the SMART tool provides Angel with insights about her students as novices and allows her to actually see the details of what they are producing. This rich source of information from the SMART method in turn refines Angel's constructivist beliefs by continually shaping her view of her students as novice learners.

The idea that the use of the SMART method is influenced by Angel's beliefs about learners, and that her beliefs about learners are in turn refined, problematizes the fidelity view of tool use. Rather than focus on how closely an instructor implemented an instructional tool to how was designed; it is more realistic to view the implementation of an instructional tool from the perspective that an instructor's beliefs about learning will affect and be affected by their use of the tool. Focusing on

143

an instructor's ability to implement an instructional tool as it was intended, assumes that they are able to assimilate the tool into their beliefs without the tool having any effect on their beliefs. This is counter-productive to the entire purpose of using instructional tools for formative assessment; teachers should be continually reforming their instructional beliefs.

Chapter 7: Conclusion

The SMART Method

The Salient Map Analysis for Research and Teaching (SMART) method is a novel way to analyze a set of concept maps. It simultaneously compares students' maps to each other and to an instructor's expected concept map. The product of the analysis is a composite map that depicts, with colors and percentages, the similarities and differences between the students' and instructor's maps.

To conduct the analysis, instructors compare students' maps to the concept map they expected, and to other students' maps. Specifically, they are looking for the presence of the instructor expected propositions on the students' maps and for novel student generated propositions. The presence of these propositions, and their frequency, is tallied on worksheets as the analysis progresses. The instructor has to make key decisions about which propositions are qualitatively similar and which constitute a different proposition completely. The map highlights instructor expected propositions missing from most students' maps in **red** text, correct student generated propositions in BLUE text, and incorrect student generated propositions in *GREEN* text.

Rationale

The concept mapping literature describes many different analysis techniques that produce numerical scores of concept maps. Many of these concept map scoring methods depend on the hierarchical structure of the concept map in order to work.

This is fundamentally flawed because not all concept maps necessarily demand a hierarchical structure. It is much more logical for the content of a concept map to be structured in the fashion that makes sense to the creator of the map, whether that is linear, network, cyclical, spoke, etc. The other main problem with existing concept map scoring methods is that they only produce a score. While numerical scores provide instructors information about the relative quality of students' maps (assuming the scoring method is reliable and valid), they fail to provide instructors specific information about the content of the students' maps for further instructional action.

Utility as a Formative Assessment

The SMART method is a productive formative assessment tool because it has the capacity to produce a wide array of useful information for instructors about their students' maps and the ideas depicted in the maps. Instructors can use the tool to track changes across time in students' concept maps. The SMART method highlights problematic and alternative conceptions that students include on their maps. The color patterns formed by the composite maps allow instructors to make rapid inferences about their classes as a whole.

Implications for Computer Automated Analysis

The bulk of the time spent performing the SMART analysis is devoted to comparing propositions that feature the same concepts, to each other to determine if they are qualitatively similar or not. It is possible for portions of the analysis to be performed by a computer program to streamline the process. The computer would produce lists of propositions from students' maps that all contain the same concepts.

Then the instructor could read through the lists and designate which propositions are

qualitatively similar and which are unique. Theoretically the program could be

designed to take the instructor's input about the propositions and generate the

composite map from it, with settings to control the percentages for the thresholds for

highlighted propositions.

When I mentioned this possibility to Angel, she felt that computerizing the

actual analysis process might cause the instructor to lose some of the benefit of doing

the actual analysis.

> Angel: Hmm...there's something about seeing the detail though map after map that you might lose.
> Laura: Well you would be able to look at the maps.
> Angel: No I get that, but I'm saying there's something in the process of grabbing it yourself.
> Laura: Oh you think.
> Angel: Yeah I do. Although I could see with shortcuts.
> Laura: Maybe you should see both, like you should see the map and the list of concepts. Like you should scroll through both.
> Angel: Yeah, because even the manner in which they place something on the page I think may have some significance to them.
> Laura: Hmm
> Angel: Like how they might center it. And like I might have chosen to make neurotransmitter the center in here but they chose ANS, and so just to kind of see that even.
> Laura: Oh, that's interesting.

It's important to note here that Angel has identified there is a trade-off

between efficient analysis of concept maps and instructor's depth of understanding

from the analysis. Angel's intuitive insights about the SMART method, and the value

of it to instructors, reiterate some of the many reasons why I chose to focus on her as

the subject of a case study about an instructor using the SMART method.

147

Rationale

EMS as a profession is relatively new, with roots in most places in the United States traced back into the late 1960s and early 1970s. The field of EMS education has rapidly evolved alongside the new medical profession. Research literature on EMS education is relatively sparse with most publications dating to the late 1990s or newer. A majority of this literature focuses on systems level problems and much of it is exploratory, survey-based. While the National EMS Research Agenda (NHTSA, 2001) calls for systems, curricular, and pedagogical research; curricular research is minimal and pedagogical research is scarce. In an attempt to begin to show EMS educators the benefits of pedagogical research, I conducted a case study of an EMS educator using the SMART method to analyze her students' concept maps.

Case Study Findings and Implications for EMS Education

Angel has a complex view of her students as novices. This goes along with her constructivist beliefs that learning is a sense-making process. Angel views the SMART method as a tool that she can learn from and invests a great deal of time into using it to understand her students' concept maps. This results in Angel learning about her students' ideas, and highlights for her two important implications for EMS education. The first is the need for EMS education curricula to have more time built in for revisiting content. The second is for instructors to help students develop critical thinking skills and help them learn to make tough decisions about the gray world of patient care instead of oversimplifying concepts into a false black and white

dichotomy. Angel's newly informed views about her students as novices and her reflections on EMS education, are likely to refine her beliefs about learning. This in turn, has implications for how educators should frame the study of teachers implementing new instructional tools and take into consideration the likelihood that not only will teachers' beliefs affect their use of the tool, but also their use of the tool will refine their beliefs.

Reflections as EMT and EMS Educator

Over my fifteen years as an EMT and five years as an EMT instructor, I have been amazed to watch the pace at which the profession is changing. When I first started in the profession, it was a big deal whenever our skill set was modified or our medical orders changed. It happened infrequently and there were big formal trainings to help us understand the changes each time, and make sure nobody was left out of the loop. Now our skill set and medical orders change drastically on an annual basis. The change process has become routine and we're expected to keep up with the pace on our own through online training. Many of these changes have drastic impacts on the public, and clash with their perception of the care we are expected to provide. Recent examples include termination of resuscitation in the field and implementing spinal protection, instead of spinal immobilization, for the vast majority of injured patients.

Many of these recent changes in our EMS protocols have arisen from an increased amount of EMS clinical research. Some of this research has upended long held tenets in the EMS professional about how to treat and care for patients. Just as

we are learning from the clinical research that EMS is its own unique brand of medicine with a need for high quality research; so too is EMS education.

Our profession is unique because we are training people who often have no medical background to understand just enough about human physiology to recognize and intervene in life threatening situations. Yet we also expect them to understand how to act as frontline primary care providers and crisis mental health providers when other segments of the medical system fail. This is a lot to ask of a person starting with approximately 150 hours of training. Not only are we teaching such critically important and vast medical skills to EMS students but we also need to take into consideration the diverse population who comprise EMS students. In just my five years as an EMS educator, I have taught students who range from age sixteen to people in their late sixties (by my best estimate, they could have been older!). I have been tasked with helping students who can questionably read at the high school level alongside experienced physicians and lawyers. It is very rare to encounter such diversity in a classroom setting and it certainly complicates the research tasks that lie ahead. While I realize that the research I present here only scratches the surface of expanding the horizon of EMS education research, I hope that, like the pace at which I have seen the profession change, that is the pace at which EMS education is about to expand.

Appendices

McAleese defines a concept map as "a directed acyclic n-dimensional graph consisting of a set of *m* Concept Labels {C1 . . . Cn} and a non-empty set of *r* Relationships or Arcs {R1 . . . Rn}" (McAleese, 1998, p. 3). This definition draws upon the semantic network literature. A semantic network can be defined as "a graphic notation for representing knowledge in patterns of interconnected nodes and arcs" (Sowa, 1991, p. 32). McAleese uses a semiotic approach to describe how signs are used to represent all of the compressed concepts and relationships behind a singular concept at a node (McAleese, 1999). He also goes on to argue that concept maps lose their acyclical nature once an attempt is made to decompress the concept map by defining the concept nodes with more specific propositions linking the concepts within the map (McAleese, 1998).

Number	Qualitatively Similar Propositions (**Concept** <u>linking words</u> **Concept**)	Tally	Percentage

Appendix B – Student Generated Propositions Worksheet

Letter	Related Codes	**Qualitatively Similar Propositions** (Concept <u>linking words</u> Concept)	Correct vs. Incorrect	Tally	%

One of the biggest interpretation challenges were concept maps containing linking lines without arrowheads, called non-directional propositions. I observed this interpretation challenge in all three cohorts of students' maps. It did not matter whether the students had drawn their maps by hand, with software not specifically designed for concept mapping, or with Cmap Tools. It helps to code maps with non-directional arrows last in a set of students' maps for reasons that will become clear shortly.

First I am going to discuss the theoretical implications of incorrectly interpreting a students' non-directional proposition. There are three possible ways to correctly interpret a student's non-directional proposition. The three ways are: 1) interpret as qualitatively similar to an instructor's expected proposition, 2) interpret as qualitatively similar to an existing student generated proposition, or 3) interpret as a new, unique student generated proposition. There are also four possible ways to incorrectly interpret a student's non-directional proposition, some of which result in skewed percentages reflected on the composite map. The four ways are: 1) misinterpret as qualitatively similar to an instructor's expected proposition, 2) fail to interpret as qualitatively similar to an instructor's expected proposition, 3) misinterpret as qualitatively similar to a student generated proposition, and 4) fail to interpret as qualitatively similar to a student generated proposition. See Table 2 for an outline of each type of interpretation error and the resulting effect on the composite map.

If a students' non-directional proposition is misinterpreted as qualitatively similar to an instructor's expected proposition, then the percentage of students' maps containing a qualitatively similar proposition to the instructor's expected proposition is falsely inflated. This means that the similarity between what the instructor and students' view as salient is overestimated. If one fails to interpret a student's non-directional proposition as qualitatively similar to an instructor's expected proposition, then the percentage of students' maps containing a qualitatively similar proposition to the instructor's expected proposition is falsely lowered. Potentially this error may lead to the highlighting of the instructor's expected proposition on the composite map.

If a students' non-directional proposition is misinterpreted as qualitatively similar to a student generated proposition, then the percentage of students' map containing a qualitatively similar proposition is falsely inflated. This means that the occurrence of the student generated proposition is overestimated. Potentially the overestimation led to the inclusion of a student generated proposition in the composite map that would not have met the threshold for highlighting otherwise. If one fails to interpret a student's non-directional proposition as qualitatively similar to a student generated proposition, then the percentage of students' maps containing a qualitatively similar proposition is falsely lowered. Potentially this error may lead to the student generated proposition not meeting the threshold for highlighting on the composite map.

Let's look at an example, Student 2's diabetes concept map from Figure 4. Student 2's diabetes map contains many examples of non-directional propositions. In

155

the center of student 2's diabetes concept map, there is a non-directional proposition linking cardiac disease and hypertension. It is not clear whether the student intended for the propositional statement to be interpreted as: 1) "cardiac disease can cause hypertension" or 2) "hypertension can cause cardiac disease." Either way this is a student generated proposition, so it can be interpreted in one of two ways, as qualitatively similar to an existing student generated proposition or as a new, unique student generated proposition. There is already a student generated proposition for the statement "hypertension can cause cardiac disease," letter code H. This means that the major decision here is whether or not to assign letter code H to the non-directional propositional statement and potentially create one of two possible errors or designate a new letter code for the opposite direction statement, "cardiac disease can cause hypertension." In this case the decision is made easier because no matter the choice made, the composite map is not affected. Even coding both of these student's propositions as letter code H, qualitatively similar student generated propositions, they did not meet the threshold for highlighting on the composite map. It was decided to assign letter code "H". This minimizes the importance of making an interpretation decision about the directionality of the student's proposition. In my experience analyzing concept maps with the SMART method, whenever an interpretation decision has to be made, it is rare that such a decision affects the content of the composite map.

CmapTools, the software program the paramedic students used to construct their concept maps, has settings to control arrowheads on the linking lines. Depending on the setting chosen by the concept mapper: 1) the arrowheads are always drawn, 2) drawn at the end of each line connecting to a concept, 3) only drawn when the linking line is drawn in an upwards direction, or 4) never drawn. Based upon the mixture of arrows and non-directional linking lines in Figure 4, it appears student 2 had either the second or third option selected when drawing their map. For instance, if a student had the second option selected and connected directly from a concept to an existing propositional statement, as may happen when linking more than two concepts to a single propositional statement, then an arrowhead would not be depicted on the line. These settings and/or the manner in which student 2 chose to draw their concept map contributed to interpretation problems during the SMART analysis (Figure 4).

Title	Date	Publication	Issue	Volume	Pages	Author	Name
A pediatric emergencies training program for emergency medical services	DEC 1985	Pediatric Emergency Care	4	1	177-179	Eichelberger	, M. R.
Reader Attitudes Toward Journal-Based Continuing Education for EMS Personnel	1997	Prehospital and Disaster Medicine	4	12	25-30	Moshinskie	, James F.
Effectiveness of interactive videodisc instruction for the continuing education of paramedics	SEP 1994	Prehospital and Disaster Medicine	3	9	70; discussio	Heller	, M.
The perceived importance of paramedic skills and the emphasis they receive during EMS education programs	JAN 1997	Prehospital Emergency Care	4	1	263-268	Pollock	, M. Jane
A breathing manikin model for teaching nasotracheal intubation to EMS professionals	OCT 1997	Prehospital Emergency Care	4	1	269-272	March	, JA
Current status of clinical education in paramedic programs: a descriptive research project	DEC 1997	Prehospital and Disaster Medicine	4	12	250-257	Grubbs	, K. C.
Identifying victims of elder abuse and neglect: a training video for prehospital personnel	DEC 1997	Prehospital and Disaster Medicine	4	12	269-273	Seamon	, J. P.
A comparison of paramedic didactic training hours and NREMT-P examination performance	JAN 1998	Prehospital Emergency Care	2	2	141-144	Cannon	, Glenn M.
A comparison of classroom and distance learning techniques for rural EMT-I instruction	JAN 1998	Prehospital Emergency Care	3	2	189-191	Hobbs	, Gregory D.
International development of emergency medical systems: educational techniques for the future	MAR 1998	European Journal of Emergency Medicine: Official Journal of the European Society for Emergency Medicine	1	5	23-27	Hojnoski	, J. A.

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
A pediatric emergencies training program for emergency medical services	DEC 1985		X				
Reader Attitudes Toward Journal-Based Continuing Education for EMS Personnel	1997	X					
Effectiveness of interactive videodisc instruction for the continuing education of paramedics	SEP 1994	X	X				
The perceived importance of paramedic skills and the emphasis they receive during EMS education programs	JAN 1997	X			X		
A breathing manikin model for teaching nasotracheal intubation to EMS professionals	OCT 1997	X	X			X	
Current status of clinical education in paramedic programs: a descriptive research project	DEC 1997	X			X		
Identifying victims of elder abuse and neglect: a training video for prehospital personnel	DEC 1997	X	X				
A comparison of paramedic didactic training hours and NREMT-P examination performance	JAN 1998	X					
A comparison of classroom and distance learning techniques for rural EMT-I instruction	JAN 1998			X			
International development of emergency medical systems: educational techniques for the future	MAR 1998	X					

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
A pediatric emergencies training program for emergency medical services	DEC 1985					X	
Reader Attitudes Toward Journal-Based Continuing Education for EMS Personnel	1997						
Effectiveness of interactive videodisc instruction for the continuing education of paramedics	SEP 1994						
The perceived importance of paramedic skills and the emphasis they receive during EMS education programs	JAN 1997						
A breathing manikin model for teaching nasotracheal intubation to EMS professionals	OCT 1997						X
Current status of clinical education in paramedic programs: a descriptive research project	DEC 1997						
Identifying victims of elder abuse and neglect: a training video for prehospital personnel	DEC 1997				X		
A comparison of paramedic didactic training hours and NREMT-P examination performance	JAN 1998	X					
A comparison of classroom and distance learning techniques for rural EMT-I instruction	JAN 1998						
International development of emergency medical systems: educational techniques for the future	MAR 1998						

Title	Date	Publication	Issue	Volume	Pages	Author Name	
An evaluation of EMS educational programs in North Carolina	JAN 1999	Prehospital Emergency Care	2	3	157-162	Brown	, Lawrence H.
A death education curriculum for emergency physicians, paramedics, and other emergency personnel	MAR 1999	Prehospital Emergency Care	1	3	37-41	Smith	, TL
Training for rural prehospital providers: a retrospective analysis from Montana	JUL 1999	Prehospital Emergency Care	3	3	231-238	Pullum	, JD
Improved paramedic sensitivity in identifying stroke victims in the prehospital setting	JUL 1999	Prehospital Emergency Care	3	3	207-210	Smith	, WS
Education of paramedics regarding aspirin use	MAR 2000	Prehospital Emergency Care	1	4	62-64	Funk	, D
Training paramedics: emergency care for children with special health care needs	JUN 2000	Prehospital emergency care: official journal of the National Association of EMS Physicians and the National Association of State EMS Directors	2	4	178-185	Spaite	, D. W.
Survey of nationally registered emergency medical services providers: Pediatric education	JUL 2000	Annals of Emergency Medicine	1	36	33-38	Glaeser	, Peter W.
Increasing paramedics' comfort and knowledge about children with special health care needs	NOV 2000	The American Journal of Emergency Medicine	7	18	747-752	Spaite	, Daniel W.

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
An evaluation of EMS educational programs in North Carolina	JAN 1999	X			X		
A death education curriculum for emergency physicians, paramedics, and other emergency personnel	MAR 1999	X	X				
Training for rural prehospital providers: a retrospective analysis from Montana	JUL 1999	X		X			
Improved paramedic sensitivity in identifying stroke victims in the prehospital setting	JUL 1999	X	X				X
Education of paramedics regarding aspirin use	MAR 2000	X	X				X
Training paramedics: emergency care for children with special health care needs	JUN 2000	X	X		X		
Survey of nationally registered emergency medical services providers: Pediatric education	JUL 2000	X			X		
Increasing paramedics' comfort and knowledge about children with special health care needs	NOV 2000	X	X		X		

162

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
An evaluation of EMS educational programs in North Carolina	JAN 1999						
A death education curriculum for emergency physicians, paramedics, and other emergency personnel	MAR 1999		X				
Training for rural prehospital providers: a retrospective analysis from Montana	JUL 1999						
Improved paramedic sensitivity in identifying stroke victims in the prehospital setting	JUL 1999						
Education of paramedics regarding aspirin use	MAR 2000						
Training paramedics: emergency care for children with special health care needs	JUN 2000					X	
Survey of nationally registered emergency medical services providers: Pediatric education	JUL 2000					X	
Increasing paramedics' comfort and knowledge about children with special health care needs	NOV 2000					X	

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Training with video imaging improves the initial intubation success rates of paramedic trainees in an operating room setting.	JAN 2001	Annals of Emergency Medicine	1	37	46-50	Levitan ,	Richard M.
Automated external defibrillator training and skill retention at a ski patrol	JUL 2002	Prehospital Emergency Care	3	6	325-329	Usatch ,	BR
Assessment of nationally registered emergency medical technician certification training in the United States: The LEADS project	MAR 2003	Prehospital Emergency Care	1	7	114	Dawson ,	Drew E.
Teaching ACLS stroke objectives to prehospital providers: a case-based approach	APR 2003	Prehospital Emergency Care	2	7	229-234	Crocco ,	TJ
Prehospital rapid-sequence intubation: a pilot training program	APR 2003	Prehospital Emergency Care	2	7	235-240	Kaye ,	K
A comparison of first-responder automated external defibrillator (AED) application rates and characteristics of AED training	OCT 2003	Prehospital Emergency Care	4	7	453-457	Lerner ,	EB
Effectiveness of an Adult-learning, Self-directed Model Compared with Traditional Lecture-based Teaching Methods in Out-of-hospital Training	2004	Academic Emergency Medicine	1	11	33-37	De Lorenzo ,	Robert A.
The effect of two death education programs on emergency medical technicians	2004	The University of Maryland, College Park Doctoral Dissertations				Smith-Cumberland '	Tracy Lynne
A randomized, prospective, multisite comparison of pediatric prehospital training methods	FEB 2004	Pediatric Emergency Care	2	20	94-100	Sanddal ,	Nels D.
Albuterol sulfate administration by EMT-Basics: results of a demonstration project	MAR 2004	Prehospital Emergency Care	1	8	34-40	Markenson ,	D

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Training with video imaging improves the initial intubation success rates of paramedic trainees in an operating room setting.	JAN 2001	X	X			X	
Automated external defibrillator training and skill retention at a ski patrol	JUL 2002	X	X				
Assessment of nationally registered emergency medical technician certification training in the United States: The LEADS project	MAR 2003	X			X		
Teaching ACLS stroke objectives to prehospital providers: a case-based approach	APR 2003		X	X			
Prehospital rapid-sequence intubation: a pilot training program	APR 2003	X	X			X	
A comparison of first-responder automated external defibrillator (AED) application rates and characteristics of AED training	OCT 2003	X			X		
Effectiveness of an Adult-learning, Self-directed Model Compared with Traditional Lecture-based Teaching Methods in Out-of-hospital Training	2004			X			
The effect of two death education programs on emergency medical technicians	2004	X	X				
A randomized, prospective, multisite comparison of pediatric prehospital training methods	FEB 2004	X	X				
Albuterol sulfate administration by EMT-Basics: results of a demonstration project	MAR 2004	X	X				

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
Training with video imaging improves the initial intubation success rates of paramedic trainees in an operating room setting.	JAN 2001						
Automated external defibrillator training and skill retention at a ski patrol	JUL 2002						
Assessment of nationally registered emergency medical technician certification training in the United States: The LEADS project	MAR 2003	X					
Teaching ACLS stroke objectives to prehospital providers: a case-based approach	APR 2003						
Prehospital rapid-sequence intubation: a pilot training program	APR 2003						
A comparison of first-responder automated external defibrillator (AED) application rates and characteristics of AED training	OCT 2003						
Effectiveness of an Adult-learning, Self-directed Model Compared with Traditional Lecture-based Teaching Methods in Out-of-hospital Training	2004						
The effect of two death education programs on emergency medical technicians	2004		X				
A randomized, prospective, multisite comparison of pediatric prehospital training methods	FEB 2004					X	
Albuterol sulfate administration by EMT-Basics: results of a demonstration project	MAR 2004						

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Public health department training of emergency medical technicians for bioterrorism and public health emergencies: results of a national assessment	2005	Journal of Public Health Management and Practice	6	11	S68–S74	Markenson	, David
Instructor quality affecting emergency medical technician (EMT) preparedness: a LEADS project	2005	International Journal of Training and Development	4	9	256-270	Russ-Eft	, Darlene F.
Advanced Hazmat Life Support (AHLS): Development and Demographics from 1999 through 2003	2005	The Internet Journal of Rescue and Disaster Medicine	1	5		Walter	, Frank
The Impact of Training and Experience on EMS Providers' Feelings Toward Pediatric Emergencies in a Rural State	JAN 2005	Pediatric Emergency Care	1	21	12-17	Stevens	, Sandra L.
Feasibility of Sternal Intraosseous Access by Emergency Medical Technician Students	MAR 2005	Prehospital Emergency Care	1	9	73-8	Miller	, David D.
Education and practice. The state of EMS Education Research Project: characteristics of EMS educators	APR 2005	Prehospital Emergency Care	2	9	203-212	Ruple	, JA
Focus on airway management. Defining the "learning curve" for paramedic student endotracheal intubation	APR 2005	Prehospital Emergency Care	2	9	156-162	Wang	, HE
An Interventional Study to Improve Paramedic Diagnosis of Stroke	SEP 2005	Prehospital Emergency Care	3	9	297-302	Bray	, Janet E.
Web-Based Training for EMT Continuing Education	SEP 2005	Prehospital Emergency Care	3	9	333-7	Jerin	, John M.
The Role of Bachelor's Degree Emergency Medical Services Programs in the Professionalization of Paramedicine	DEC 2005	University of Pittsburgh Doctoral Dissertations				Margolis	, Gregg S.

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Public health department training of emergency medical technicians for bioterrorism and public health emergencies: results of a national assessment	2005	X			X		
Instructor quality affecting emergency medical technician (EMT) preparedness: a LEADS project	2005	X			X		
Advanced Hazmat Life Support (AHLS): Development and Demographics from 1999 through 2003	2005	X	X				
The Impact of Training and Experience on EMS Providers' Feelings Toward Pediatric Emergencies in a Rural State	JAN 2005	X			X		
Feasibility of Sternal Intraosseous Access by Emergency Medical Technician Students	MAR 2005	X	X				
Education and practice. The state of EMS Education Research Project: characteristics of EMS educators	APR 2005	X			X		
Focus on airway management. Defining the "learning curve" for paramedic student endotracheal intubation	APR 2005	X				X	
An Interventional Study to Improve Paramedic Diagnosis of Stroke	SEP 2005	X	X				X
Web-Based Training for EMT Continuing Education	SEP 2005	X		X	X		
The Role of Bachelor's Degree Emergency Medical Services Programs in the Professionalization of Paramedicine	DEC 2005	X					

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
Public health department training of emergency medical technicians for bioterrorism and public health emergencies: results of a national assessment	2005			X			
Instructor quality affecting emergency medical technician (EMT) preparedness: a LEADS project	2005						
Advanced Hazmat Life Support (AHLS): Development and Demographics from 1999 through 2003	2005						
The Impact of Training and Experience on EMS Providers' Feelings Toward Pediatric Emergencies in a Rural State	JAN 2005					X	
Feasibility of Sternal Intraosseous Access by Emergency Medical Technician Students	MAR 2005						
Education and practice. The state of EMS Education Research Project: characteristics of EMS educators	APR 2005						
Focus on airway management. Defining the "learning curve" for paramedic student endotracheal intubation	APR 2005						
An Interventional Study to Improve Paramedic Diagnosis of Stroke	SEP 2005						
Web-Based Training for EMT Continuing Education	SEP 2005						
The Role of Bachelor's Degree Emergency Medical Services Programs in the Professionalization of Paramedicine	DEC 2005						

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Effects of an Educational Intervention on Prehospital Pain Management	MAR 2006	Prehospital Emergency Care	1	10	71-6	French	, Scott C.
EMTs' Attitudes' Toward Death Before and After a Death Education Program	MAR 2006	Prehospital Emergency Care	1	10	89-95	Smith-Cumberland	, Tracy L.
Program accreditation effect on paramedic credentialing examination success rate	APR 2006	Prehospital Emergency Care	2	10	224-228	Dickison	, P
Commonalities of the EMS Education Workforce (2004) in the United States	APR 2006	Prehospital Emergency Care	2	10	229-238	Ruple	, JA
Development, Implementation and Outcomes of a Training Program for Responders to Acts of Terrorism	JUN 2006	Prehospital Emergency Care	2	10	239-46	Miller	, Geoffrey T.
The internationalisation of prehospital education: a merging of ideologies between Australia and the USA	JUL 2006	Emergency Medicine Journal : EMJ	7	23	573-577	Williams	, B
Skill improvement during emergency response to terrorism training	OCT 2006	Prehospital Emergency Care	4	10	507-514	Scott	, JA
Feasibility of Basic Emergency Medical Technicians to Perform Selected Advanced Life Support Interventions	DEC 2006	Prehospital Emergency Care	4	10	518-21	Guyette	, Francis X.
A Novel Inexpensive IV Catheterization Training Model for Paramedic Students	DEC 2006	Prehospital Emergency Care	4	10	515-7	Parwani	, Vivek
Endotracheal Intubation: Application of Virtual Reality to Emergency Medical Services Education	2007	Simulation In Healthcare	4	2	231-234	Mayrose	, James
Paramedic perceptions of challenges in out-of-hospital endotracheal intubation	2007	Prehospital Emergency Care	2	11	219–223	Thomas	, Jane Boyce

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Effects of an Educational Intervention on Prehospital Pain Management	MAR 2006	X	X		X		
EMTs' Attitudes' Toward Death Before and After a Death Education Program	MAR 2006	X	X				
Program accreditation effect on paramedic credentialing examination success rate	APR 2006	X					
Commonalities of the EMS Education Workforce (2004) in the United States	APR 2006	X					
Development, Implementation and Outcomes of a Training Program for Responders to Acts of Terrorism	JUN 2006		X				
The internationalisation of prehospital education: a merging of ideologies between Australia and the USA	JUL 2006	X		X	X		
Skill improvement during emergency response to terrorism training	OCT 2006	X	X				
Feasibility of Basic Emergency Medical Technicians to Perform Selected Advanced Life Support Interventions	DEC 2006	X					
A Novel Inexpensive IV Catheterization Training Model for Paramedic Students	DEC 2006		X		X		
Endotracheal Intubation: Application of Virtual Reality to Emergency Medical Services Education	2007		X			X	
Paramedic perceptions of challenges in out-of-hospital endotracheal intubation	2007	X				X	

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Effects of an Educational Intervention on Prehospital Pain Management	MAR 2006						
EMTs' Attitudes' Toward Death Before and After a Death Education Program	MAR 2006		X				
Program accreditation effect on paramedic credentialing examination success rate	APR 2006	X					
Commonalities of the EMS Education Workforce (2004) in the United States	APR 2006						
Development, Implementation and Outcomes of a Training Program for Responders to Acts of Terrorism	JUN 2006			X			
The internationalisation of prehospital education: a merging of ideologies between Australia and the USA	JUL 2006						
Skill improvement during emergency response to terrorism training	OCT 2006			X			X
Feasibility of Basic Emergency Medical Technicians to Perform Selected Advanced Life Support Interventions	DEC 2006						
A Novel Inexpensive IV Catheterization Training Model for Paramedic Students	DEC 2006						
Endotracheal Intubation: Application of Virtual Reality to Emergency Medical Services Education	2007						X
Paramedic perceptions of challenges in out-of-hospital endotracheal intubation	2007						

Title	Date	Publication	Issue	Volume	Pages	Author Name	
The Effectiveness of a Novel, Algorithm-Based Difficult Airway Curriculum for Air Medical Crews Using Human Patient Simulators	MAR 2007	Prehospital Emergency Care	1	11	72-9	Davis	, Daniel P.
Launching online education for 911 telecommunicators and EMS personnel: experiences from the North Carolina Rapid Response to Stroke project	JUL 2007	Prehospital Emergency Care	3	11	298-306	Lellis	, JC
Education Program on Prehospital Skill Maintenance in Key Resuscitation Areas	OCT 2007	The Journal of Emergency Medicine	3	33	293-297	De Lorenzo	, Robert A.
Paramedic student adherence to the national standard curriculum recommendations	OCT 2007	Prehospital Emergency Care	4	11	448-452	Salzman	, JG
Disaster Training for Prehospital Providers	DEC 2007	Prehospital Emergency Care	4	11	458-65	Chaput	, Christine J.
A study of the teaching strategies of paramedic educators as they relate to models of adult education	2008	University of Hartford Doctoral Dissertations				DeVito	, Theresa Rucci
Estimating the Probability of Passing the National Paramedic Certification Examination	2008	Academic Emergency Medicine	3	15	258-264	Fernandez	, Antonio R.
Influences of situated cognition on tracheal intubation skill acquisition in paramedic education	2008	Texas A&M University Doctoral Dissertations				Villers	, Lance Carlton
Strategies of high-performing EMT-basic educational programs	APR 2008	Prehospital Emergency Care	2	12	206-211	Margolis	, GS
Effect of paramedic student internship on performance on the national registry written exam	APR 2008	Prehospital Emergency Care	2	12	212-216	Salzman	, J

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
The Effectiveness of a Novel, Algorithm-Based Difficult Airway Curriculum for Air Medical Crews Using Human Patient Simulators	MAR 2007		X			X	
Launching online education for 911 telecommunicators and EMS personnel: experiences from the North Carolina Rapid Response to Stroke project	JUL 2007	X	X				X
Education Program on Prehospital Skill Maintenance in Key Resuscitation Areas	OCT 2007		X				
Paramedic student adherence to the national standard curriculum recommendations	OCT 2007	X					
Disaster Training for Prehospital Providers	DEC 2007	X	X		X		
A study of the teaching strategies of paramedic educators as they relate to models of adult education	2008			X	X		
Estimating the Probability of Passing the National Paramedic Certification Examination	2008	X			X		
Influences of situated cognition on tracheal intubation skill acquisition in paramedic education	2008	X			X	X	
Strategies of high-performing EMT-basic educational programs	APR 2008	X					
Effect of paramedic student internship on performance on the national registry written exam	APR 2008	X					

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
The Effectiveness of a Novel, Algorithm-Based Difficult Airway Curriculum for Air Medical Crews Using Human Patient Simulators	MAR 2007						X
Launching online education for 911 telecommunicators and EMS personnel: experiences from the North Carolina Rapid Response to Stroke project	JUL 2007						
Education Program on Prehospital Skill Maintenance in Key Resuscitation Areas	OCT 2007						
Paramedic student adherence to the national standard curriculum recommendations	OCT 2007						
Disaster Training for Prehospital Providers	DEC 2007			X			
A study of the teaching strategies of paramedic educators as they relate to models of adult education	2008						
Estimating the Probability of Passing the National Paramedic Certification Examination	2008	X					
Influences of situated cognition on tracheal intubation skill acquisition in paramedic education	2008						
Strategies of high-performing EMT-basic educational programs	APR 2008	X					
Effect of paramedic student internship on performance on the national registry written exam	APR 2008	X					

175

Title	Date	Publication	Issue	Volume	Pages	Author Name	
The effect of the geriatrics education for emergency medical services training program in a rural community	JUN 2008	Journal of the American Geriatrics Society	6	56	1134-1139	Shah	, MN
Emergency medical services education, community outreach, and protocols for stroke and chest pain in North Carolina	JUL 2008	Prehospital Emergency Care	3	12	366-371	Brice	, JH
Impact of a Restraint Training Module on Paramedic Students' Likelihood to Use Restraint Techniques	SEP 2008	Prehospital Emergency Care	3	12	388-92	Campbell	, Micha
An Experimental Predeployment Training Program Improves Self-Reported Patient Treatment Confidence and Preparedness of Army Combat Medics	SEP 2008	Prehospital Emergency Care	3	12	359-65	Gerhardt	, Robert T.
Is online pediatric continuing education effective in a rural state?	OCT 2008	Prehospital Emergency Care	4	12	498-502	Warren	, L
The Association Between Emergency Medical Technician-Basic (EMT-B) Exam Score, Length of EMT-B Certification, and Success on the National Paramedic Certification Exam	2009	Academic Emergency Medicine	9	16	881-886	Fernandez	, Antonio R.
Comparison of video feedback with traditional evaluation form in emergency medical services continuing medical education	2009	The University of Utah Doctoral Dissertations				Hulphers	, Eric Aron
The feasibility of daily mannequin practice to improve intubation success	2009	Air medical journal	4	28	195–197	Lubin	, Jeffrey
Emergency Medical Service Attitudes Toward Geriatric Prehospital Care and Continuing Medical Education in Geriatrics	2009	Journal of the American Geriatrics Society	3	57	530-535	Peterson	, Lars-Kristofer N.

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
The effect of the geriatrics education for emergency medical services training program in a rural community	JUN 2008	X	X		X		
Emergency medical services education, community outreach, and protocols for stroke and chest pain in North Carolina	JUL 2008	X			X		X
Impact of a Restraint Training Module on Paramedic Students' Likelihood to Use Restraint Techniques	SEP 2008	X	X				
An Experimental Predeployment Training Program Improves Self-Reported Patient Treatment Confidence and Preparedness of Army Combat Medics	SEP 2008		X		X		
Is online pediatric continuing education effective in a rural state?	OCT 2008	X	X				
The Association Between Emergency Medical Technician-Basic (EMT-B) Exam Score, Length of EMT-B Certification, and Success on the National Paramedic Certification Exam	2009	X					
Comparison of video feedback with traditional evaluation form in emergency medical services continuing medical education	2009		X				
The feasibility of daily mannequin practice to improve intubation success	2009	X	X			X	
Emergency Medical Service Attitudes Toward Geriatric Prehospital Care and Continuing Medical Education in Geriatrics	2009	X					

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
The effect of the geriatrics education for emergency medical services training program in a rural community	JUN 2008				X		
Emergency medical services education, community outreach, and protocols for stroke and chest pain in North Carolina	JUL 2008						
Impact of a Restraint Training Module on Paramedic Students' Likelihood to Use Restraint Techniques	SEP 2008						
An Experimental Predeployment Training Program Improves Self-Reported Patient Treatment Confidence and Preparedness of Army Combat Medics	SEP 2008			X			
Is online pediatric continuing education effective in a rural state?	OCT 2008					X	
The Association Between Emergency Medical Technician-Basic (EMT-B) Exam Score, Length of EMT-B Certification, and Success on the National Paramedic Certification Exam	2009	X					
Comparison of video feedback with traditional evaluation form in emergency medical services continuing medical education	2009						
The feasibility of daily mannequin practice to improve intubation success	2009						
Emergency Medical Service Attitudes Toward Geriatric Prehospital Care and Continuing Medical Education in Geriatrics	2009				X		

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Attitudes and Action Plans of North Carolina EMS Education Leaders Regarding National EMS Education Program Accreditation	2009	The University of Tennessee, Knoxville Doctoral Dissertations			81	Wilfong	, Denise Anne
Simulation-based assessment of paramedic pediatric resuscitation skills	JUL 2009	Prehospital Emergency Care	3	13	345-356	Lammers	, RI
Assessing continued cognitive competence among rural emergency medical technicians	JUL 2009	Prehospital Emergency Care	3	13	357-363	Studnek	, Jr
The relationship between paramedics' level of education and degree of commitment	SEP 2009	The American Journal of Emergency Medicine	7	27	830-837	Alexander	, Melissa
Strategies of high-performing paramedic educational programs	OCT 2009	Prehospital Emergency Care	4	13	505-511	Margolis	, GS
Using Computer-Based Clinical Simulations to Improve Student Scores on the Paramedic National Credentialing Examination	2010	The Ohio State University Doctoral Dissertations				Dickison	, Philip DuWayne
Taking the pulse of training transfer: Instructor quality and EMT certification examination results	2010	Human Resource Development Quarterly	3	21	291-306	Russ-Eft	, Darlene F.
Paramedic training for proficient prehospital endotracheal intubation	MAR 2010	Prehospital Emergency Care	1	14	103-108	Warner	, KJ
Educational outreach to improve emergency medical services systems of care for stroke in Montana	APR 2010	Prehospital Emergency Care	2	14	259-264	Oser	, Carrie, S.
Death notification training for prehospital providers: a pilot study	OCT 2010	Prehospital Emergency Care	4	14	537-542	Ponce	, A

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Attitudes and Action Plans of North Carolina EMS Education Leaders Regarding National EMS Education Program Accreditation	2009	X					
Simulation-based assessment of paramedic pediatric resuscitation skills	JUL 2009	X	X				
Assessing continued cognitive competence among rural emergency medical technicians	JUL 2009	X					
The relationship between paramedics' level of education and degree of commitment	SEP 2009	X					
Strategies of high-performing paramedic educational programs	OCT 2009	X					
Using Computer-Based Clinical Simulations to Improve Student Scores on the Paramedic National Credentialing Examination	2010		X	X			
Taking the pulse of training transfer: Instructor quality and EMT certification examination results	2010	X			X		
Paramedic training for proficient prehospital endotracheal intubation	MAR 2010	X				X	
Educational outreach to improve emergency medical services systems of care for stroke in Montana	APR 2010	X			X		X
Death notification training for prehospital providers: a pilot study	OCT 2010	X	X				

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
Attitudes and Action Plans of North Carolina EMS Education Leaders Regarding National EMS Education Program Accreditation	2009						
Simulation-based assessment of paramedic pediatric resuscitation skills	JUL 2009					X	X
Assessing continued cognitive competence among rural emergency medical technicians	JUL 2009	X					
The relationship between paramedics' level of education and degree of commitment	SEP 2009						
Strategies of high-performing paramedic educational programs	OCT 2009	X					
Using Computer-Based Clinical Simulations to Improve Student Scores on the Paramedic National Credentialing Examination	2010	X					X
Taking the pulse of training transfer: Instructor quality and EMT certification examination results	2010	X					
Paramedic training for proficient prehospital endotracheal intubation	MAR 2010						
Educational outreach to improve emergency medical services systems of care for stroke in Montana	APR 2010						
Death notification training for prehospital providers: a pilot study	OCT 2010		X				

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Among Emergency Medicine Undergraduate Students	2011	University of Pittsburgh Honors Thesis				Borrell	, Jessica L.
Continuing Professional Education Needs Assessments in Emergency Medical Services	2011	The University of Georgia Doctoral Dissertations				Frasard	, Scott Ryan
The Association Between Emergency Medical Services Field Performance Assessed by High-fidelity Simulation and the Cognitive Knowledge of Practicing Paramedics	2011	Academic Emergency Medicine	11	18	1177-1185	Studnek	, Jonathan R.
Teaching Emergency Medical Services Management Skills Using a Computer Simulation Exercise	JAN 2011	Simulation in Healthcare	1	6	1	Hubble	, Michael W.
Paramedic Accuracy Using SALT Triage After a Brief Initial Training	OCT 2011	Prehospital Emergency Care	4	15	526-532	Deluhery	, Matthew, R
Pediatric Educational Needs Assessment for Urban and Rural Emergency Medical Technicians	DEC 2011	Pediatric emergency care	12	27	1130-1135	Fleischman	, Ross J.
A Novel Internet-Based Geriatric Education Program for Emergency Medical Services Providers	2012	Journal of the American Geriatrics Society	9	60	1749-1754	Shah	, Manish N.
Interevaluator Reliability of a Mock Paramedic Practical Examination	APR 2012	Prehospital Emergency Care	2	16	277-283	Martin	, Melisa
Understanding of Sepsis among Emergency Medical Services: A Survey Study	JUN 2012	The Journal of Emergency Medicine	6	42	666-677	Seymour	, Christopher W.
Evaluation of Field Triage Decision Scheme Educational Resources Audience Research With Emergency Medical Service Personnel	MAR 2013	Health Promotion Practice	2	14	174-180	Sarmiento	, Kelly

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Among Emergency Medicine Undergraduate Students	2011	X			X		
Continuing Professional Education Needs Assessments in Emergency Medical Services	2011	X			X		
The Association Between Emergency Medical Services Field Performance Assessed by High-fidelity Simulation and the Cognitive Knowledge of Practicing Paramedics	2011	X					
Teaching Emergency Medical Services Management Skills Using a Computer Simulation Exercise	JAN 2011	X	X				
Paramedic Accuracy Using SALT Triage After a Brief Initial Training	OCT 2011		X				
Pediatric Educational Needs Assessment for Urban and Rural Emergency Medical Technicians	DEC 2011	X	X		X		
A Novel Internet-Based Geriatric Education Program for Emergency Medical Services Providers	2012	X	X				
Interevaluator Reliability of a Mock Paramedic Practical Examination	APR 2012	X					
Understanding of Sepsis among Emergency Medical Services: A Survey Study	JUN 2012	X			X		
Evaluation of Field Triage Decision Scheme Educational Resources Audience Research With Emergency Medical Service Personnel	MAR 2013	X	X				

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
Among Emergency Medicine Undergraduate Students	2011	X					
Continuing Professional Education Needs Assessments in Emergency Medical Services	2011						
The Association Between Emergency Medical Services Field Performance Assessed by High-fidelity Simulation and the Cognitive Knowledge of Practicing Paramedics	2011	X					X
Teaching Emergency Medical Services Management Skills Using a Computer Simulation Exercise	JAN 2011						X
Paramedic Accuracy Using SALT Triage After a Brief Initial Training	OCT 2011			X			
Pediatric Educational Needs Assessment for Urban and Rural Emergency Medical Technicians	DEC 2011					X	
A Novel Internet-Based Geriatric Education Program for Emergency Medical Services Providers	2012				X		
Interevaluator Reliability of a Mock Paramedic Practical Examination	APR 2012						
Understanding of Sepsis among Emergency Medical Services: A Survey Study	JUN 2012						
Evaluation of Field Triage Decision Scheme Educational Resources Audience Research With Emergency Medical Service Personnel	MAR 2013			X			

184

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Prehospital Sepsis Project (PSP): Knowledge and Attitudes of United States Advanced Out-of-Hospital Care Providers	APR 2013	Prehospital and Disaster Medicine	2	28	104–106	Báez ,	Amado Alejandro
Prehospital Mass-Casualty Triage Training--Written Versus Moulage Scenarios: How Much Do EMS Providers Retain?	JUN 2013	Prehospital and Disaster Medicine	3	28	251-6	Risavi ,	Brian L.
A National Assessment of the Roles and Responsibilities of Training Officers	JUL 2013	Prehospital Emergency Care	3	17	373-378	Bentley ,	Melissa, A.
Longitudinal and Regional Trends in Paramedic Student Exposure to Advanced Airway Placement: 2001-2011	JUL 2013	Prehospital Emergency Care	3	17	379-385	Westgard ,	Bjorn, C.
Managing Multiple-Casualty Incidents: A Rural Medical Preparedness Training Assessment	AUG 2013	Prehospital and Disaster Medicine	4	28	334-41	Glow ,	Steven D.
Emergency Medical Services Capacity for Prehospital Stroke Care in North Carolina	SEP 2013	Preventing Chronic Disease		10		Patel ,	Mehul D.
Death in the Field: Teaching Paramedics to Deliver Effective Death Notifications Using the Educational Intervention "GRIEVING"	OCT 2013	Prehospital Emergency Care	4	17	501-510	Hobgood ,	Cherri
Objectives, taxonomies and competencies of community oriented and community based education applied to community paramedicine	2014	J Contemp Med Edu	3	2	193	Leggio ,	William Joseph
The Relationship of Affective Domains and Cognitive Performance in Paramedic Students	2014	University of South Florida Doctoral Dissertations				Lyman ,	Katie J.
Creation and Delphi-method Refinement of Pediatric Disaster Triage Simulations	APR 2014	Prehospital Emergency Care	2	18	282-289	Cicero ,	Mark, X.
High-fidelity Human Patient Simulators Compared with Human Actors in an Unannounced Mass-Casualty Exercise	APR 2014	Prehospital and Disaster Medicine	2	29	176-82	Schulz ,	Christian M.

185

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Prehospital Sepsis Project (PSP): Knowledge and Attitudes of United States Advanced Out-of-Hospital Care Providers	APR 2013	X	X		X		
Prehospital Mass-Casualty Triage Training-- Written Versus Moulage Scenarios: How Much Do EMS Providers Retain?	JUN 2013	X	X				
A National Assessment of the Roles and Responsibilities of Training Officers	JUL 2013	X			X		
Longitudinal and Regional Trends in Paramedic Student Exposure to Advanced Airway Placement: 2001-2011	JUL 2013	X				X	
Managing Multiple-Casualty Incidents: A Rural Medical Preparedness Training Assessment	AUG 2013	X	X				
Emergency Medical Services Capacity for Prehospital Stroke Care in North Carolina	SEP 2013	X			X		X
Death in the Field: Teaching Paramedics to Deliver Effective Death Notifications Using the Educational Intervention "GRIEVING"	OCT 2013	X	X				
Objectives, taxonomies and competencies of community oriented and community based education applied to community paramedicine	2014	X					
The Relationship of Affective Domains and Cognitive Performance in Paramedic Students	2014	X					
Creation and Delphi-method Refinement of Pediatric Disaster Triage Simulations	APR 2014		X				
High-fidelity Human Patient Simulators Compared with Human Actors in an Unannounced Mass-Casualty Exercise	APR 2014	X					

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Prehospital Sepsis Project (PSP): Knowledge and Attitudes of United States Advanced Out-of-Hospital Care Providers	APR 2013						
Prehospital Mass-Casualty Triage Training-- Written Versus Moulage Scenarios: How Much Do EMS Providers Retain?	JUN 2013			X			
A National Assessment of the Roles and Responsibilities of Training Officers	JUL 2013						
Longitudinal and Regional Trends in Paramedic Student Exposure to Advanced Airway Placement: 2001-2011	JUL 2013						
Managing Multiple-Casualty Incidents: A Rural Medical Preparedness Training Assessment	AUG 2013			X			
Emergency Medical Services Capacity for Prehospital Stroke Care in North Carolina	SEP 2013						
Death in the Field: Teaching Paramedics to Deliver Effective Death Notifications Using the Educational Intervention "GRIEVING"	OCT 2013		X				
Objectives, taxonomies and competencies of community oriented and community based education applied to community paramedicine	2014						
The Relationship of Affective Domains and Cognitive Performance in Paramedic Students	2014						
Creation and Delphi-method Refinement of Pediatric Disaster Triage Simulations	APR 2014			X		X	X
High-fidelity Human Patient Simulators Compared with Human Actors in an Unannounced Mass-Casualty Exercise	APR 2014			X			X

Title	Date	Publication	Issue	Volume	Pages	Author Name	
Exploring Paramedic Student Leadership Characterstics in Emergency Medical Services Education Programs: A Grounded Theory Study	JUL 2014	Creighton University Doctoral Dissertations				Miller	, Michael G.
Emergency Medical Services Response to Active Shooter Incidents: Provider Comfort Level and Attitudes Before and After Participation in a Focused Response Training Program	AUG 2014	Prehospital and Disaster Medicine	4	29	350-7	Jones	, Jerrilyn
EMSC program manager survey on education of prehospital providers	SEP 2014	Prehospital emergency care: official journal of the National Association of EMS Physicians and the National Association of State EMS Directors	3	18	424-428	Ngo	, Thuy L.
The Attrition Condition: Use of a Preparatory Course to Reduce EMT Course Attrition and Improve Performance on North Carolina Certification Exams	OCT 2014	Prehospital Emergency Care	2	19	260-266	Renkiewicz	, Ginny K.
Simulation Use in Paramedic Education Research (SUPER): A Descriptive Study	2015	Prehospital Emergency Care				McKenna	, Kim D.

Title	Date	System	Curricula	Pedagogical	Survey Method	Airway	Cardiovascular / Stroke
Exploring Paramedic Student Leadership Characterstics in Emergency Medical Services Education Programs: A Grounded Theory Study	JUL 2014	X					
Emergency Medical Services Response to Active Shooter Incidents: Provider Comfort Level and Attitudes Before and After Participation in a Focused Response Training Program	AUG 2014	X	X		X		
EMSC program manager survey on education of prehospital providers	SEP 2014	X			X		
The Attrition Condition: Use of a Preparatory Course to Reduce EMT Course Attrition and Improve Performance on North Carolina Certification Exams	OCT 2014	X	X				
Simulation Use in Paramedic Education Research (SUPER): A Descriptive Study	2015	X			X		

189

Title	Date	Certification	Death	Disaster	Geriatric	Pediatric	Simulation
Exploring Paramedic Student Leadership Characterstics in Emergency Medical Services Education Programs: A Grounded Theory Study	JUL 2014						
Emergency Medical Services Response to Active Shooter Incidents: Provider Comfort Level and Attitudes Before and After Participation in a Focused Response Training Program	AUG 2014						
EMSC program manager survey on education of prehospital providers	SEP 2014					X	
The Attrition Condition: Use of a Preparatory Course to Reduce EMT Course Attrition and Improve Performance on North Carolina Certification Exams	OCT 2014	X					
Simulation Use in Paramedic Education Research (SUPER): A Descriptive Study	2015						X

Cohort 1: Autonomic Nervous System Concept Map Assignment

Concept Map
Assignment #1: Autonomic Nervous System Map
Due Date: Tuesday 9/13 at 8 AM
Value: 25 points

Instructions:
Construct a concept map using Cmap Tools found at http://cmap.ihmc.us/   You are welcome to explore the site, but to download the program select *Download*. Select *CmapTools*. Include all of the following terms in your concept map. Keep the information to 1 page single sided with margins (approximately ½ inch) around the sides. Print your concept map and bring it to me and hand it in before the exam on Tuesday. Make sure you write your name on the map.

Concepts:

Acetylcholine
Adrenergic
Autonomic nervous system
Cholinergic
Epinephrine/Norepinephrine
Feed or Breed
Fight or Flight
Neurotransmitter
Parasympathetic nervous system
Parasympatholytic effects
Parasympathomimetic effects
Sympathetic nervous system
Sympatholytic effects
Sympathomimetic effects

Cohort 1: Diabetes Concept Map Assignment

Concept Map
Assignment #2: Diabetes Map
Due Date: Tuesday 3/6 at 8 AM
Value: 25 points

Instructions:
Construct a concept map using Cmap Tools found at http://cmap.ihmc.us/   You are welcome to explore the site, but to download the program select *Download*. Select *CmapTools*. Include all of the following terms in your concept map. Keep the information to 1 page single sided with margins (approximately ½ inch) around the sides. Print your concept map and bring it to me and hand it in before the exam on Tuesday. Make sure you write your name on the map.

Concepts:

Atherosclerosis
Blood Glucose Level
Cardiac Disease
Diabetes
Diabetic Ketoacidosis
Glucagon
Hypertension
Insulin
Kidney Failure
Neuropathy
Obesity
Pancreas
Peripheral Vascular Disease
Type 1 Diabetes
Type 2 Diabetes

Cohort 2: Autonomic Nervous System Concept Map Assignment

Concept Map
Assignment #1: Autonomic Nervous System Map
Due Date: Tuesday 9/6 at 8 AM
Value: 10 points

Instructions:
Construct a concept map using Cmap Tools found at http://cmap.ihmc.us/   You are
welcome to explore the site, but to download the program select *Download*. Select
CmapTools. Include all of the following terms in your concept map. Keep the
information to 1 page single sided with margins (approximately ½ inch) around the
sides. Print 2 copies of your concept map, one to turn in and one to use as a study
tool. Make sure you write your name on the map.

Concepts:

Acetylcholine
Adrenergic
Autonomic nervous system
Cholinergic
Epinephrine/Norepinephrine
Feed or Breed
Fight or Flight
Neurotransmitter
Parasympathetic nervous system
Parasympatholytic effects
Parasympathomimetic effects
Sympathetic nervous system
Sympatholytic effects
Sympathomimetic effects

Cohort 2: Respiratory Medicines Concept Map Assignment

Concept Map
Assignment #2: Bronchodilators Map
Assigned: October 11
Due Date: Tuesday October 16 prior to exam 1
Value: 10 points

Instructions:
Construct a concept map using Cmap Tools found at http://cmap.ihmc.us/   Keep the information to 1 page single sided with margins (approximately ½ inch) around the sides. Print your concept map and hand it in before the exam on Tuesday. Make sure you write your name on the map. Include all of the following terms in your concept map.

- Beta2 Agonist
- Bronchial Smooth Muscles
- Bronchodilation
- Magnesium Sulfate
- Methylxanthines
- Muscarinic Receptors
- Non-specific Beta Agonist
- Parasympatholytics
- Sympathomimetics

Additional instructions to the Concept Map:
1) Include the subclasses of bronchodilator drugs from the lecture (power point presentation).
2) Briefly describe the effects noted with each subclass.
3) Use the drug handout from Canvas (Respiratory Drugs Fill-In) to identify each drug that should be included in the concept map.

Cohort 2: Shock Concept Map Assignment

Concept Map
Assignment #3: Shock Map
Due Date: Tuesday 10/23 at 8 AM
Value: 10 points

Instructions:
Construct a concept map using Cmap Tools. Include all of the following terms in your concept map. Keep the information to 1 page single sided with margins (approximately ½ inch) around the sides. Make sure you write your name on the map.

Concepts:

Blood Pressure
Cardiac Output
Compensated
Decompensated
Heart Rate
Homeostasis
Irreversible
Organ Failure
Perfusion
Peripheral Vascular Resistance
Pulse Pressure
Shock
Stroke Volume

SMART Testimonial

SMART Testimonial
Cohort 1 ANS Analysis Part 3
[00:25:59.25] Angel describes how the SMART method is more superior than item analysis on testing because she gets group feedback on how effective instruction has been, which she doesn't feel she gets from item analysis or discrimination indexes. She can see clusters and relationships that she wouldn't see as quickly on her own without the composite map. (Add to Chap 3 describing SMART Method)

Angel: But what this does do, which I already can, I already believe this is far superior to simply testing and item analysis on testing.
Laura: Uh huh
Angel: What I do get from this is group feedback...
Laura: Mmmhmm
Angel: ...on how effective instruction has been, which I don't think I can, I've ever been able to achieve simply with analyzing test scores and looking at discrimination indexes. So, I can see clusters, I can see relationships, I can see things that I've, I'm not able to do on my own as quickly as I could do right here looking at this diagram. So I think this is really, really helpful.

SMART Testimonial
Diabetes Analysis Part 2
[00:05:36.06] Laura compliments Angel's system of numbering propositions and transcribing them to the worksheets.

Laura: And I think your system of catching it all is a good system. Cause this is a really complicated map.
Angel: Oh yeah.
Laura: Yeah. I like that system.
Angel: Well good. Yeah well that was how I noticed two of em were missing actually. And it was when there was cause this looks like one out, but then when I get to here it's one two three four five six out.
Laura: Yeah the branching...
Angel: That's how I got six and seven on my total here. I actually had to go back and recount.
Laura: Yeah, I think we got em all.
Angel: Yepper, so I'll let you keep that cause it was one page where I kind of screwed up anyways so I made it an error page.
Laura: Huh, cool.

Angel: Anyway so you keep that.
Laura: Okay, so...

ONLY USEFUL AS A DESCRIPTION OF HOW SHE WAS APPROACHING THIS
PARTICULAR WAY OF THINKING ABOUT THE ANALYSIS, FOR THE BELOW
DISCUSSION

SMART Testimonial
Diabetes Analysis Part 2
[00:06:30.22]Angel thinks that looking at the connections at each node might be helpful
for our higher level thinking about the topic, ie. diabetes.

Angel is doing the exact same thing here that I do when I pick out problematic concepts.
SMART tool really does allow an instructor to easily identify problematic concepts to
revisit in the classroom.

Angel: That might also, I don't know if that could help in the our higher level
thinking about this too or not, I mean just to look at it too and go wow
the topic was diabetes and this stuff was connected but look at all this
peripheral stuff and wait a minute how come all these zeros. It might
help with the uh critical thinking piece to this, I don't know.
Laura: Yeah. I definitely want to think about that more. Umm, especially in
helping design these. Umm helping instructors design these.
Angel: Yeah. Yeah, be...
Laura: These are definitely...
Angel: One of the things...
Laura: ...interesting way to think about it...

SMART Testimonial
Diabetes Analysis Part 2
[00:07:05.26] Angel brings up how she talked about being involved in this research at a
faculty meeting recently and how valuable this research is to any instructor who has been
teaching for more than 10 years. It allows her to see how the students are thinking like
novices. Now instead of seeing a student choose an incorrect test answer and just being
completely baffled by their answer, analyzing these maps is helping her to understand
their thinking patterns. WOW WOW WOW!!! She can see that she is making
assumptions that the students are making logical leaps that they clearly are not making.

Explicit novice expert
Flexibility of tools, allowing a national expert to think differently about her students.

Angel: When I was speaking yesterday about your project in the division
meeting. I'll put it on the tape for you now, but umm, yesterday at
school, umm we were doing a celebration of the end of the semester.
And umm our department chair asked us to each speak about our
learning outcome projects and our teaching improvement projects

197

and that's part of our requirement as faculty members we each have to be working on an approved teaching improvement or learning outcome every year.

Laura: Uh huh

Angel: And they don't have to be huge, they just have to be something that's showing that we're analyzing what we're doing and improving.

Laura: Okay

Angel: And so me talking about our project which is a formal research, you're working on your dissertation. Obviously its a big deal.

Laura: Okay.

Angel: I mean it was a big, big deal.

Laura: Okay

Angel: Umm, but I was talking with the faculty members one of the things that I mentioned to them that this process has done for me is I said you know any of us that have been teaching for ten years or fifteen years or twenty years sometimes the students and maybe even other educators will tell us that we've lost the ability to think like a novice and to recognize what a novice is going through...

Laura: Mmmhmm

Angel: ...because we're content experts now and we've mastered it and so we sort of forget those struggles that we go through. But I said one thing that this project has done to help me with is going back and analyzing the students' this allows me to analyze the students' thought processes in a way I haven't been able to do before. And it really gives me a lot of insight because sometimes when they answer test questions and I walk away from that I think why did they pick that answer, that's ridiculous, you know.

Laura: Yeah

Angel: There's no way that answer is the correct answer, but then when I see their thinking processes illustrated here in the way they've shown me how they've made the connections, I can go back and go oh, now I, even though it's still flawed and wrong.

Laura: Yeah.

Angel: I can actually sort of see the path...

Laura: Uh huh

Angel: ...that they took to get to that wrong answer a little bit clearer. And it kind of helps me realize that I make assumptions that there con...making connections of logic that they're really not.

Laura: Mmm hmm

Angel: And so this has really helped, this you know analyzing that previous map and I'm sure with this one too it'll help me see how these are really complicated processes and its not an easy thing for them to get this the first pass. And that we need to keep trying to create ways that they can continue to manipulate this.

SMART Testimonial

Diabetes Analysis Part 2

[01:02:11.14] Angel suggests a code for going in the right direction, but not quite there, ie. mostly correct. She wants this because the last student's statement was partially incorrect, but partially correct, so she is having to decide which it lies more with.

> Angel: You oughta have another con... thing here for umm instead of making it a fifty-fifty you oughta have a code here that's you know going the right direction but not quite type of a code. You know what I mean?
>
> Laura: Ohh
>
> Angel: Like they're on track but they're just not there yet.
>
> Laura: [laughter] Huh. Like a...
>
> Angel: Mostly correct, or partially correct.
>
> Laura: Like maybe a number scale, like a Likert scale instead of correct versus incorrect, like a Likert scale in terms of how correct.
>
> Angel: Well ya one is correct, well one is correct, er one is incorrect, three is incorrect and two is on that continuum in the middle.
>
> Laura: Okay, hmm.
>
> Angel: Because somebody like that statement is partially correct, but it's also incorrect because its not detailed enough. But I wouldn't go crazy with it and then you're sitting there trying to figure out degrees. But if there's some element of correctness but not quite, because several of these incorrect ones they're in the ballpark but its just, its just not firm enough, yet.
>
> Laura: Hmm
>
> Angel: You know what I mean?
>
> Laura: That's a good idea. Umm.

Also speaks to Angel's belief of gray, not black and white, to back up novice being black and white.

SMART Testimonial

Respiratory Meds Part 2

[02:39:51.01]Angel thinks some of the differences identified between her map and the students' map would disappear if synonyms for concepts were included into qualitatively similar propositions. This prompts us to create a column with corresponding number codes for student generated propositions.

> Angel: And some of the pink and blue and that's what I was kind of getting at...some of it, if I think if we were to allow the use of sympathomimetic / umm adrenergic, you know like use the multiple terms that are acceptable here.
>
> Laura: Mmmhmm
>
> Angel: Then some of that stuff might have gone away, because...
>
> Laura: Which stuff?
>
> Angel: Umm...like here "albuterol is a sympathomimetic."

Laura: Mmmhmm

Angel: Umm "albuterol is a beta-2 agonist." And it's one type of sympathomimetic. So see what I'm saying. Albuterol is a sympathomimetic. So this is a this, this is a this, this is a this it's another layer of things which we didn't build in and I think that accounts for a lot of their correct statements is instead of talking about albuterol in terms...

Laura: Do you want to try to get rid of some of those and fix...put them in here?

Angel: Umm

Laura: I mean it's your decision.

Angel: No it doesn't, what I mean but I guess what I'm saying Laura is to see that...

Laura: Mmmhmm

Angel: ...to see them say albuterol is a beta-2 agonist or to see them have see them say albuterol is a sympathomimetic in both cases I consider a win.

Laura: Mmmhmm

Angel: Is what I'm saying, so if you want to call it a tomato and I want to call it a tOmato, we're still both correct.

Laura: So it's an artifact of the way this map is constructed is what you're saying.

Angel: Okay, if that's the right.

Laura: Yeah

Angel: If that's the right way to phrase it, yes. Yes, and so I think that accounts though for quite a bit of the blue here. See Mag sulfate bronchodilator, ipratroprium bronchodilator, Mag sulfate mineral, umm, methylxanthine subclass of bronchodilator. So see I think that's what accounts for a lot of the blue. Epinephrine sympathomimetic.

Laura: Mmmhmm

Angel: So that's pretty much all the blue. And that makes sense.

Laura: Mmmhmm

Angel: This is not a three dimensional map so we don't have that additional layer.

Laura: Yeah

Angel: And so in that case then a lot of that would go over to here if you know instead of calling it seven, nine...

Laura: Well tell you what...

Angel: Should we do that?

Laura: Let's go through these real quick, they that's what we have this column for.

Angel: Oh, okay.

Laura: Let's write the numbers here and then I can do two different...

Angel: Oh, okay.

Laura: ...versions of analysis.

Angel: Oh, okay.

Laura: Let's figure out what number these all correspond to.

Angel: If you give me the blues, or you want all of them?

Laura: Let's do all of them, cause I can do two different analysis then.

Angel: Okay, so help me again.

Laura: So I, you just want to do the corrects, right? Cause the incorrects won't map. Umm

Instructor Map "Missing" Proposition

Instructor Map "Missing" Proposition
Cohort 1 ANS Analysis Part 1
[00:15:15.12] AB discovers a missing proposition in the master map
While Angel and I are setting up the worksheets for our very first analysis meeting of the first cohort's Autonomic Nervous System maps, she notices that a proposition is "missing" from the instructor's map.

Angel: Yeah there's something else kind of missing out of there too.

Laura: What?

Angel: Parasympatholytic and Parasympathomimetic are opposite effects.

Laura: Oh, so maybe the students will catch that.

Angel: Yeah, and the same thing here Sympathomimetic and Sympatholytic are opposite effects.

What she means by "missing" is that she wishes that she had included these propositions on her instructor's predicted map. Every time Angel has a thought like this there is a little undermining of any predisposed notion that the SMART analysis is setting her up as the expert and comparing her the novices, her students. This is especially important considering my original terminology for the instructor's predicted map was the master map. This phenomenon of the instructor wanting to add additional concepts to the instructor's predicted map was not new to me. The immunology instructor also felt this way about his maps. I share this with Angel as well as a paper I read describing a method for constructing an "expert" concept map.

Laura: See we noticed lots of things like this when we went through the immunology thing.

Angel: Yeah

Laura: Like these are continually, these maps are continually improving.

Angel: Wow.

Laura: And that's why the master maps are like a true master map, like I actually found a paper that described how to make these from a panel of experts.

Angel: Really?

Laura: A process for doing that.

Angel: Just to make sure that all the nuances are caught.

Laura: Yeah

Angel: Wow, isn't that interesting.

Laura: Yeah

Angel: Alright, so I guess we did pretty good then.

Laura: Yeah, so...

Instructor Map "Missing" Proposition

Diabetes Analysis Part 2

[00:34:58.20]Angel recognizes a missing proposition on the instructor map. She wants to know how to handle that. Laura advises that we can make a note of it. Angel wants to know if she is going to get back the instructor map with the notes we made on it from the ANS map. Yeah. She views this as her own personal teaching project.

Angel views this as a productive pragmatic project, not just a research interpretive game. And this piece works to counter the SMART sets up the stage for the novice vs. expert stuff.

> Laura: "Hypertension also increases risk of peripheral vascular disease."
> Angel: That's on here, I think. Maybe we didn't make that connection.
> Laura: There is no link on the map between hypertension and PVD.
> Angel: We have neuropathy and hypertension, diabetes uncontrolled.
> Laura: Nah, there's no link between hypertension and PVD.
> Angel: Yeah, there should be. Huh.
> Laura: But there's not.
> Angel: You know I thought about that too when I was coding the map just now.
> Laura: [laughter] So that's a "G."
> Angel: Do we go back to the map then and like hand draw it in?
> Laura: No, we can I mean we can make notes like based upon I mean based upon this stuff we can make notes for like how you would want to modify this...
> Angel: ...for next time...
> Laura: ...for next time.
> Angel: Are you going to return back to me the first map as well with that those recommendations?
> Laura: Yeah, yeah.
> Angel: Great. My own personal teaching improvement project.
> Laura: Okay

Instructor Map "Missing" Proposition

Diabetes Analysis Part 2

[00:45:47.07]Angel points out that there are a few other propositions that could have appeared on the instructor map, based on what the students are including on their map. Laura reminds Angel that we didn't include those propositions on purpose because we were focusing the map on diabetes, not those other disease processes. (Perhaps this is a classic example of where a guiding focus question would have been helpful.)
Laura and Angel agree that it's good that the students are including these propositions because it shows that they know these concepts. But Laura points out how it may show that they know less about diabetes because they are focused on other diseases, not so much on diabetes. Angel thinks they might be flinging poo. Angel thinks they are only connecting backward not forward. Laura thinks they have good breadth of knowledge, but not good depth of knowledge. Laura points out how a lot of what the students are

portraying about diabetes are superficial, duh, ideas. Angel adds that they are pop science, mythy. Angel wants to know where the data for their claims is coming from.

Laura: Alright

Angel: So we needed to make a connection down here to PVD and a connection over to hypertension.

Laura: Yeah. There's a couple of extra connections and I think we didn't make them because...

Angel: ...on purpose...

Laura: ...on purpose because we were focusing on diabetes...

Angel: Right

Laura: ...not those other things.

Angel: Right but it's in...it's good, it's actually good the students...

Laura: ...are making these...

Angel: ...were are making them, yeah.

Laura: ...because its showing that they know these things but its interesting because they're not, they're making them in a sense because they know less about diabetes, if you think about it. Like we're seeing...

Angel: They're just flinging poo.

Laura: Well they're not flinging poo, it's showing what they know but its showing that they don't know as much about diabetes as you wanted, but its showing what they did actually learn throughout the class.

Angel: Well but I'm trying to think about had we taught hypertension and PVD yet and I guess we did because we'd had done cardiac [unintelligible]

Laura: Yeah cause you'd already done cardiac.

Angel: ...so they hadn't had that.

Laura: Yeah

Angel: [Unintelligible] That instruction had occurred for those two diseases.

Laura: [Unintelligible]

Angel: So they're making the connection backward is what you're saying, but they're not making the connection forward.

Laura: Well they're just, they're not focusing on the topic at hand which is diabetes like what this is showing you is that they're depth of knowledge about diabetes is not as deep as you wanted it...

Angel: Mmmhmm

Laura: ...but their breadth of knowledge about in general is fairly good but its surface level.

Angel: Right

Laura: Like a lot of these things that they're making are very surface level things.

Angel: Right

Laura: That you weren't looking for, you wanted them to really show I know diabetes really well and they're not showing that. They're showing you know a decent number of misconceptions about diabetes and I mean admittedly some of those things that they're showing about diabetes are kind of like duh things that you took for granted.

Angel: Well they're sort of....

Laura: And didn't even put on the map.

Angel: ...the pop psychology, pop science, the mythy how EMS you know talk, wants to teach absolutes and wants to put everything in a nice little box for everybody and say well this is the number one cause. Well really is it, how do you know that? You know what statistics are you using to drive that? Where is that information coming from? Is it because your instructor told you that?

This absolute comment speaks to novice ways of thinking, which helps with the earlier absolute comment.

Laura: Yeah

Angel: When you were in EMT school.

Laura: Yeah

Angel: Is it because of your own belief, is it because of what you've seen in the media...

Laura: Yeah

Angel: ...that's led you to make this conclusion? I mean what is that conclusion based on cause its definitely not based on the instructional process that you received from us. So, yeah.

Laura: That's interesting. Okay.

Instructor Map "Missing" Proposition

Respiratory Meds Part 2

[00:44:25.07]Angel discusses how she taught receptors in reference to the topic and how she would like to modify the expected map in the future. Angel notes that she would have liked to have had F, H, & K on her expected map.

Angel: "Methylxanthines cause bronchodilation." Do you have that one on your?

Laura: "Methylxanthine is a subclass of bronchodilator." I think you con... on map two considered it the same.

Angel: Okay

Laura: It's "H."

Angel: Yeah that's just this.

Laura: Okay

Angel: And its the same with this. Which will probably change the map for next time.

Laura: Okay.

Angel: Because we did that here and we did that here.

Laura: Mmmhmm

Angel: We did that there. That would make sense.

Laura: Mmmhmm

Angel: This take...this talks about the mm...

Laura: Oh yeah

Angel: And that talks about the receptors site, the receptor types. This talks

about the receptors down. This talks about receptors. This doesn't talk about receptors because we never learned about the receptors that these targeted.

Laura: Mmmhmm

Angel: And we never brought that into the conversation.

Laura: Hmm

Angel: But I did tell them this...

Laura: Mmmhmm

Angel: ...statement.

Laura: Okay

Angel: And they sort of taken a jump but yeah that'll be an extra and that'll be an...do you have parasympatholytics cause bronchodilation in there anywhere?

Laura: We have parasympatholytic is a subclass of bronchodilator.

Angel: So what is that one?

Laura: "F"

Angel: "F" Yeah so see both of those...we could definitely do that cause it that these feed into that.

Laura: Okay

Angel: And this one also I don't doubt no anybody is gonna go there maybe but that also. And I don't know if we have mag sulfate causes bronchodilation.

Laura: Yeah, magnesium sulfate is bronchodilator is "K."

Angel: Oh yeah, "K."

Laura: Do people put that?

Angel: I don't know we'll see.

Laura: Hmm

Angel: Cause I mean that's what we've been seeing people do is talk about but within the classes you know the classes and then you've got the...

Laura: Mmmhmm

Angel: ...the subclasses.

Laura: Mmmhmm

Angel: So there's three more connections that we'll probably see more frequently cause we've been seeing them so far.

Laura: Okay

Angel: Alright now this is just a silly.

Laura: So "F, H, & K" you would have liked to have had on your master?

Angel: Yeah I mean it makes sense now that looking at it.

Laura: Okay, cool.

Instructor Map "Missing" Proposition

Respiratory Meds Part 2

[02:23:45.17] Angel wants to add some concepts that the students put on their maps to her map.

Angel: But these ideas here bringing the subclasses...

Laura: Uh huh

Angel: ...showed up a lot.

Laura: Okay

Angel: So, how, I saw K showed up a very large point. How about F and H, how often did they show up? F showed up a lot. H showed up a lot. And K...

Laura: K

Angel: K, yeah and see those three are the ones we added in. They showed up a lot. Bringing them in to bronchodilators.

Laura: Even M broke, M showed up slightly more than half the class.

Angel: Yeah and see that's because we didn't go into, that might be interesting though to say that you know beta-2 agonist mainly target lungs. Non-specific target heart and lungs. That might be important.

Laura: And look, look at the opposite of them, we've got selective beta-2 agonist action primarily on lungs and then you get non-specific beta-2 agonist which means it could cause effects other than those to the lungs. So you've got these opposites here.

Angel: Right, so it's showed up on almost 100% of them then.

Laura: Mmmhmm

Angel: Yeah so I think it would be good here to add in umm, so this can come out, or it could stay but we with the understanding that we're not gonna see it a lot. But for next year this here about umm... Now see the statement here would be: may target and then heart and lungs or how would you write it?

Laura: You write it.

Angel: No but I mean how do ya...target...heart and lungs...like that? That's showed up in a whole bunch of them.

Laura: Okay

Angel: What was that, how many? Let's put it in there. How many times did we see that? That's an M? And what was the other one, that was the opposite?

Laura: What you could do, is you could umm...

Angel: What was the other one that you found?

Laura: Think about what the concept word would be like maybe it's umm like maybe the concept word would be lungs.

Angel: It's heart and lungs.

Laura: But maybe the concept word would be lungs and then you could say beta-2 agonists only affect lungs and then non-specific beta agonists affect...

Angel: [Unintelligible]

Laura: Other umm affect you know, I'm lacking words and lungs. [laughter] That would tie them in.

Angel: Okay, I mean you can pretty it up however you want, but I wanted to kind of get it in here, so it was M and then there was another one you found. Where was it?

Laura: Mmm, its oh its the VV or UU woah, VV.

Angel: Primarily on the lungs. Okay VV.

Laura: And M.
Angel: And then beta-2 prim...umm primarily on the lungs. Oh that was VV.
Laura: Mmmhmm
Angel: So that was it.
Laura: Mmmhmm
Angel: Right?
Laura: Mmmhmm

Instructor Map "Missing" Proposition
Respiratory Meds Part 2
[02:27:58.18]Angel thinks that the appearance of three propositions on students' maps is cool and surprising. She wants to add them to her map.

Angel: I also thought it was interesting that so many of them brought up the concept of the bronchial smooth muscles. How many times did that show up? G, I, X, Y, VV [misread, means UU] And then we had it on here.
Laura: Well then yeah you can look at the map [unintelligible]
Angel: Yeah
Laura: One and two and five
Angel: One, two, and five...so there was quite a and this is the only one where I said anything about bronchial smooth muscles in relation to bronchial...bronchodilation.
Laura: Mmmhmm
Angel: So but that's really what it's really doing in all cases.
Laura: Yeah, yeah
Angel: But that's the one
Laura: So they link it into all of them.
Angel: Yeah, which is cool! But that's something that I'm surprised that they picked up on, I'm glad it was good.
Laura: Mmmhmm
Angel: And you know this down here was kind of a peripheral in the world of trivia.
Laura: Mmmhmm
Angel: But yeah we definitely need to add those three.
Laura: Okay
Angel: And...

Correct student generated ideas get categorized as either superficial, oops I should have had on my map, or way too deep for our purposes.

Instructor Map "Missing" Proposition
Shock
[01:33:36.29] Angel notices that we didn't include a proposition on our map that we should have. She describes a student's map as jumbled thinking. Angel defends amount of time student may have spent on the map, Laura contradicts with surveys. Angel describes how medicine is not black and white but gray and it's hard for students to recognize that. Angel describes how students struggle to recognize subtle trends.

Angel: That is so weird that we didn't make any connection between blood pressure and shock [laughter] that's just weird.

Laura: [laughter]

Angel: Umm, so we have that in there somewhere cause one of the students said it. Shock uh blood pressure and...uh lower...

Laura: Shock is directly related to blood pressure or more specific...

Angel: Well shock BP lowers blood pressure.

Laura: Low BP is a late sign of shock.

Angel: No, low blood pressure equals shock basically is what this says.

Laura: All we have is low BP is a late sign is shock.

Angel: Okay, well then this is a new one.

Laura: Okay

Angel: Umm

Laura: RR

Angel: Yeah...umm...

Laura: So how do you want to word it?

Angel: I don't know. Low blood pressure is...equals shock, I guess. I mean that's how I'm reading this. Shock BP lowers blood pressure. Blood pressure lowers shock. Shock lower...they're saying that...am I reading too much into it?

Laura: I think that they're trying to say that like low blood pressure...

Angel: ...equals shock.

Laura: ...equals shock.

Angel: Yeah and that's what I'm seeing there too. That's fine. That's what I'm seeing.

Laura: So you don't want to code that though as umm...low BP is a late sign of shock?

Angel: No, cause it's that quantifies it more than what I think...

Laura: Okay

Angel: ...this student did. They're making it a broader statement. I think that one's more narrowed.

Laura: Okay, okay.

Angel: See I don't even know what the connection is here. Cause it...man this is really jumbl..., it's really not...I'm gonna run to the restroom...

Laura: [laughter]

Angel: ...think on it. You can think on it while I'm gone...

Laura: Okay

Angel: ...cause it's very jumbled thinking. And it's kind of all over the place. [01:37:02.11]

[bathroom break]

Instructor Map "Missing" Proposition
Shock
[01:46:47.20]

Angel: That's okay. Yeah, next time I added this.

208

Laura: Oh cool

Angel: And then we'll have to put a number in for it.

Laura: [unintelligible] shock

Angel: ...is low blood pressure.

Laura: equals blood pressure, okay.

Angel: And organ failure leads to death. We've seen that a couple times too but...

Laura: Okay

Angel: And then there's the equations

Laura: Okay

Angel: So it's the output, heart rate stroke volume equals output. Heart rate stroke volume vascular resistance equals blood pressure output times vascular resistance, I taught them all three.

Laura: So how you put two blood pressure equations and the cardiac output equation.

Angel: Yeah we've got two. Two ways of expressing it.

Laura: Alright. Okay.

Angel: So

Laura: Cool, awesome.

Angel: Yeah and I'm not sure because again with that being like that I'm not sure how you add that in without doubling up on the words which you don't want to do and I think that maybe that's why we didn't put them in.

Laura: I don't necessarily think we need to add them in, I think its a neat phenomena that they added them in.

Angel: Uh okay.

Laura: That's what I thought...

Angel: So maybe we put that as part of the key or something for the next time. But this is something I'm seeing that I want to reinforce with each of them, more physiology.

Laura: Okay

Black vs. White (Opposite of Constructivist)

Black vs. White (Opposite of Constructivist)
Cohort 1 ANS Analysis Part 1
[01:22:51.03] Angel notices that most of the student generated propositions are correct and she is happy to see this. Laura informs her this is the same pattern observed with the immunology student data.

Black vs. white, opposite of constructivist. Structure of SMART method requires categorizing correct vs. incorrect, but a person can also choose to view students as that way, either incorrect or correct, which Angel is doing here.

Angel: Well I'm glad they're generalizations for the most part are correct. That's good to see. Yeah. Yeah.

Laura: All the student generated...

Angel: ...propositions.
Laura: Yes. Yeah, we saw this, we saw this with what we did too.
Angel: Yeah.
Laura: Yeah, it's interesting. Umm...

Did not cherry pick data, this came up infrequently.

Black vs. White (Artifact of SMART Analysis)

Black vs. White (Artifact of SMART Analysis)
Cohort 1 ANS Analysis Part 2
[00:08:45.22] Talk about how to code battling arrows.

Laura and Angel are coding several student generated propositions on a student's concept map. One part of the coding is to categorize whether the student's propositions are correct or incorrect. The following conversation which focuses on the correctness of a student's propositions is likely the result of the particular construct of the SMART method in this study. Please remember that instead of categorizing students' propositions based upon correctness, another criteria could have been used.
Angel: Now if they go through to the neuroreceptor or neurotransmitter, then it is a true statement.
Laura: But they don't cause we have...
Angel: But they don't.
Laura: ...battling arrows.
Angel: Right.
Laura: [laughter]
Angel: So if they, if that's what they meant, then they would have been correct.
Laura: Yeah.
Angel: Okay, so is that it for that map.
Laura: No, we have two more. We have sympathetic nervous system, sympathetic uses adrenergic.
Angel: And that's a mis-statement, so VV. Sympathetic uses epi/norepi.
Laura: No adrenergic.
Angel: Or adrenergic. Yeah epi/norepi would be the correct.
Laura: Yeah. I was about to say.
Angel: And then parasympathetic...
Laura: Uses cholinergic. And that is WW.
Angel: WW.
Laura: Alright.
Angel: WW2, the big one.

Black vs. White (Novice Way of Thinking)
Diabetes Analysis Part 2
[00:20:40.09] Angel talks about student using absolute terms. Angel identifies how a student's proposition is correct, but student generated, because when constructing the instructor map, we did not think students would make that connection, so we did not include it on the map.

Is this black vs. white interpretation her viewing the student as a novice? Ask her? Yes this is, see later passage that clarifies.

> Angel: See this person is, really is talking in absolutes. You know what I mean?
> Laura: Yeah.
> Angel: Major risk, most common...
> Laura: Yeah, they're getting very specific.
> Angel: Yeah
> Laura: Umm, "diabetes increases risk of peripheral vascular disease."
> Angel: It's a truthful statement and we did not make that connection ourselves. We went through neuropathy to PVD.
> Laura: Huh
> Angel: It could, we talked, we actually talked about that when we built the map.
> Laura: Okay
> Angel: So it's not an untruthful statement, we just didn't think...
> Laura: Okay
> Angel: ...the students would jump there.
> Laura: Okay. So this get's a "B?"
> Angel: Yeah

Black vs. White (Novice Way of Thinking)
Diabetes Analysis Part 2
[00:45:47.07]Angel points out that there are a few other propositions that could have appeared on the instructor map, based on what the students are including on their map. Laura reminds Angel that we didn't include those propositions on purpose because we were focusing the map on diabetes, not those other disease processes. (Perhaps this is a classic example of where a guiding focus question would have been helpful.)
Laura and Angel agree that its good that the students are including these propositions because it shows that they know these concepts. But Laura points out how it may show that they know less about diabetes because they are focused on other diseases, not so much on diabetes. Angel thinks they might be flinging poo. Angel thinks they are only connecting backward not forward. Laura thinks they have good breadth of knowledge, but not good depth of knowledge. Laura points out how a lot of what the students are portraying about diabetes are superficial, duh, ideas. Angel adds that they are pop science, mythy. Angel wants to know where the data for their claims is coming from.

Laura: Alright
Angel: So we needed to make a connection down here to PVD and a connection over to hypertension.
Laura: Yeah. There's a couple of extra connections and I think we didn't make them because...
Angel: ...on purpose...
Laura: ...on purpose because we were focusing on diabetes...
Angel: Right
Laura: ...not those other things.
Angel: Right but it's in...it's good, it's actually good the students...
Laura: ...are making these...
Angel: ...were are making them, yeah.
Laura: ...because it's showing that they know these things but its interesting because they're not, they're making them in a sense because they know less about diabetes, if you think about it. Like we're seeing...
Angel: They're just flinging poo.
Laura: Well they're not flinging poo, it's showing what they know but its showing that they don't know as much about diabetes as you wanted, but its showing what they did actually learn throughout the class.
Angel: Well but I'm trying to think about had we taught hypertension and PVD yet and I guess we did because we'd had done cardiac [unintelligible]
Laura: Yeah cause you'd already done cardiac.
Angel: ...so they hadn't had that.
Laura: Yeah
Angel: [Unintelligible] That instruction had occurred for those two diseases.
Laura: [Unintelligible]
Angel: So they're making the connection backward is what you're saying, but they're not making the connection forward.
Laura: Well they're just, they're not focusing on the topic at hand which is diabetes like what this is showing you is that they're depth of knowledge about diabetes is not as deep as you wanted it...
Angel: Mmmhmm
Laura: ...but their breadth of knowledge about in general is fairly good but its surface level.
Angel: Right
Laura: Like a lot of these things that they're making are very surface level things.
Angel: Right
Laura: That you weren't looking for, you wanted them to really show I know diabetes really well and they're not showing that. They're showing you know a decent number of misconceptions about diabetes and I mean admittedly some of those things that they're showing about diabetes are kind of like duh things that you took for granted.
Angel: Well they're sort of....
Laura: And didn't even put on the map.

Angel: ...the pop psychology, pop science, the mythy how EMS you know talk, wants to teach absolutes and wants to put everything in a nice little box for everybody and say well this is the number one cause. Well really is it, how do you know that? You know what statistics are you using to drive that? Where is that information coming from? Is it because your instructor told you that?

This absolute comment speaks to novice ways of thinking, which helps with the earlier absolute comment.

Laura: Yeah
Angel: When you were in EMT school.
Laura: Yeah
Angel: Is it because of your own belief, is it because of what you've seen in the media...
Laura: Yeah
Angel: ...that's led you to make this conclusion? I mean what is that conclusion based on cause its definitely not based on the instructional process that you received from us. So, yeah.
Laura: That's interesting. Okay.

Black vs. White (Novice Way of Thinking)
Diabetes Analysis Part 2
[01:02:11.14] Angel suggests a code for going in the right direction, but not quite there, ie. mostly correct. She wants this because the last student's statement was partially incorrect, but partially correct, so she is having to decide which it lies more with.
Angel: You oughta have another con... thing here for umm instead of making it a fifty-fifty you oughta have a code here that's you know going the right direction but not quite type of a code. You know what I mean?
Laura: Ohh
Angel: Like they're on track but they're just not there yet.
Laura: [laughter] Huh. Like a...
Angel: Mostly correct, or partially correct.
Laura: Like maybe a number scale, like a Likert scale instead of correct versus incorrect, like a Likert scale in terms of how correct.
Angel: Well ya one is correct, well one is correct, er one is incorrect, three is incorrect and two is on that continuum in the middle.
Laura: Okay, hmm.
Angel: Because somebody like that statement is partially correct, but it's also incorrect because its not detailed enough. But I wouldn't go crazy with it and then you're sitting there trying to figure out degrees. But if there's some element of correctness but not quite, because several of these incorrect ones they're in the ballpark but its just, its just not firm enough, yet.
Laura: Hmm
Angel: You know what I mean?

213

Laura: That's a good idea. Umm.

Also speaks to Angel's belief of gray, not black and white, to back up novice being black and white.

Black vs. White (Novice Way of Thinking)
Shock
[01:48:06.00]

Angel: Which I think is actually cool they're getting it but some of them aren't quite getting it all.
Laura: Okay
Angel: For example the one who didn't make the connection that there's three types.
Laura: Okay
Angel: So that'll be something to emphasize. And I kind of like to do that with some scenario things.
Laura: Mmm
Angel: Like here's some vital signs and make them vague...
Laura: Okay
Angel: ...in some cases, make them obvious in others. But make some of them vague so they actually have to declare what they think it is.
Laura: Okay
Angel: You know cause the patient's aren't always completely black and white, it's those shades of gray. And I think that that'll help drive home the idea that decompensation is the transitional stage.
Laura: Yeah
Angel: And you've got the compensated who can fairly easily recover with the right support.
Laura: Yeah
Angel: And then you've got the irreversible, which are not going to recover despite whatever support you're giving them. And then you've got that huge valley in between that is the transitioning between the two.
Laura: Yeah
Angel: And that's what some of them aren't grasping is you've got this danger zone that if you're in it early enough you might be able to save them, but if you're at it too late. And I think that's why that whole concept...
Laura: Huh
Angel: ...with Cowley and the Golden hour whatever...
Laura: Okay
Angel: You know it although all of that has been proven false now.
Laura: Yeah
Angel: I think that intellectually the concept for our medical profession...
Laura: People need to understand it.
Angel: Yeah, our relatively uneducated medical profession, I think it helps them understand. I really do, I always have.

Black vs. White (Novice Way of Thinking)
Shock
[01:49:47.26]

Laura: So what do you think about that person who had the there was a map
where they had like it could go either way. Do you think that person really
understood the decompensated stage?

Angel: They said decompensated could go either way?

Laura: I don't really remember...

Angel: No, we had the one that had compensated or uncompensated...

Laura: Yeah, yeah, yeah, yeah, no but

Angel: ...there are only two types.

Laura: Yeah, but there was the map it had weird blocks umm where they
were saying for some of the things it was either way. Yeah this one. Like
see how they said...

Angel: Uh huh

Laura: Do you think, how do you, so you think that person really...

Angel: I thin...

Laura: ...grapsing

Angel: Yes, I do because that's what you...

Laura: Number 4

Angel: Yeah because that's what, I didn't code everything in here.

Laura: Mmmhmm

Angel: With the ors, but the tendency is to have it go one direction or the
other. But the thing about umm the heart rate is gonna be dependent on
other medications. Beta blockers and things like that.

Laura: Mmmhmm

Angel: So if you could put the caveat that there's no medications influencing,
there's no kind of you know cardiac devices that are influencing rate.

Laura: Mmmhmm

Angel: That a patient without those tends to go one direction or the other.

Laura: Mmmhmm

Angel: So and I think that some of them maybe get fixated because we do talk
about and it says a lot in the book actually about if you've got a patient on
beta blockers because you want to try, we sort of want to drive the
students away from thinking in terms of absolutes.

Laura: Okay

Angel: But there are some trends that they need to recognize.

Laura: Okay

Angel: And I think that that's where they don't make the subtle difference is
in recognizing a trend.

Laura: Mmmhmm

Angel: Because of the influence of the pharmacologic thing, like a beta
blocker.

Laura: Okay

Angel: So like for example with my husband you know with his the fact that

he's on umm beta blockers and he's also on a lot of different medications because of his cardiac history he won't express with tachycardia.

Laura: Mmmhmm

Angel: And he actually when he gets on the treadmill and he goes in for his cardiac studies in his annual examinations with his cardiologist, they actually have to induce tachycardia because he won't become tachycardic even though he could be exhausted on the treadmill from running, he'll get exhausted particularly since he hasn't been on the treadmill lately. He'll be exhausted in a matter of a minute or two but he won't get tachycardic.

Laura: Mmm

Angel: And they want him to be tachycardic so they can do the stress test.

Laura: Yeah

Angel: See if he gets rhythm changes.

Laura: Yeah

Angel: So they actually have to induce it with adenosine.

Laura: Wow

Angel: To make him tachycardic so that they can then see if there's any umm EKG changes.

Laura: Wow

Angel: Yeah, and that's what happens with a lot of those folks that have to have that, they have to do the pharmacologic studies because...

Laura: Mmmhmm

Angel: ...exercise won't induce them.

Laura: Okay

Angel: Now for me who's a big lumpy on the couch potato kind of person I get tachycardic just looking at a treadmill, you know. [laughter]

Laura: Yeah

Angel: You don't even turn it on and I get tachycardic so...

Laura: Hmm

Angel: ...it makes a difference. Alright so let's get back to this map.

SMART Reveals Curricula Challenges

SMART Reveals Curricula Challenges
Cohort 1 ANS Analysis Part 3
[01:03:47.14]Angel describes how EMS teaching is a process of throwing and throwing stuff at students and seeing what sticks. She acknowledges that even though she now knows what she needs to go back and revisit, there is no time in the curriculum to do so, unless she sacrifices covering other content. She describes how she reinforces previous content as she moves forward and how the map will influence how she does that.

Angel: Well I mean you've already given me a great deal of awareness in umm it this is really a battle of throwing stuff and throwing stuff and throwing stuff and seeing how much sticks.

Laura: Mmmhmm

Angel: Right. And not a whole lot stuck. It actually a little bit less stuck then what I thought would have stuck. And we don't have a lot of time for reinforcing. Mmmhmm and although we do build.

Laura: Yeah.

Angel: We don't have a lot of time to go back and like I would not necessarily have time in the program unless I made time and sacrificed something else to walk into the classroom and say okay guys based on this map we didn't really get it, let's do the lecture again. Now I don't know how helpful that would be anyway. But I don't have time to do that, so now I just have to make sure that as I move forward I keep reinforcing these things and I do as I build on final exams I do tend to bring a 10 to 20 percent previous content...

Laura: Mmmhmm

Angel: ...into the comprehensive exam at the end for each class.

Laura: Yeah.

Angel: So I might pick one or two questions out of here to put on the test again just to kind of remind them that maybe in the past I wouldn't have done that.

Laura: Uh huh.

Angel: I would have picked other things with other topics assuming they pretty much had nailed this. But apparently they didn't. Now it will be interesting to compare this to the final because they didn't have, they don't have the exact same questions, they have similar questions on the final, so it'd be interesting to see how they did on the final in these areas.

Laura: Hmm, That's neat.

Conclusion Chapter – Power of SMART is limited by ability to change curricula. Policy change tool. My story about students struggling to learn ventilation vs. oxygenation.

SMART Reveals Curricula Challenges
Diabetes Analysis Part 2
[00:09:42.13] She highlights that a flaw of EMS education is that topics are covered only once and they not revisited because we assume that students made the connections the first time, so we move on.

Unexpected benefit, helping experienced instructor think broadly, how curricula really needs to repeat! Unique because both nitty gritty everyday nuts and bolts and big picture thinking about changes that need to happen. Do people only make changes when they can see the big picture impact?

Angel: And that's, I think that's a flaw of ALS instruction and EMT instruction in general in that we sort of we one time topic and then we move on to the next one time topic and then we move on to the next one time topic and we don't really necessarily pull it all together and make connections and help them make connections.

Laura: Mmm hmm

Angel: We just sort of assume that they're doing that as they go along.
Laura: Yeah
Angel: And even when we look at a single topic, we're seeing they're not
doing that.
Laura: Yeah, yeah

Laura Novice vs. Expert

Laura Novice vs. Expert
Cohort 1 ANS Analysis Part 1
[00:15:15.12] I reveal my novice/expert bias in describing a study.
Laura: See we noticed lots of things like this when we went through the
immunology thing.
Angel: Yeah
Laura: Like these are continually, these maps are continually improving.
Angel: Wow.
Laura: And that's why the master maps are like a true master map, like I
actually found a paper that described how to make these from a panel
of experts.
Angel: Really?
Laura: A process for doing that.
Angel: Just to make sure that all the nuances are caught.
Laura: Yeah
Angel: Wow, isn't that interesting.
Laura: Yeah
Angel: Alright, so I guess we did pretty good then.
Laura: Yeah, so...
Here I am revealing my bias towards thinking with a novice vs. expert lens. I am aware
that the instructors' maps are flawed, yet I am still seeking a way to steer them as far as
possible towards the best possible consensus expert product, as if such a thing exists.

Laura Misconception
Cohort 1 ANS Analysis Part 2
[00:04:15.13]Laura identifies a giant misconception, Angel confirms.

Example of Laura having a dominant interpretive framework: misconceptions.
Laura: So this is just one giant misconception.
Angel: It is. "Neurotransmitters, there's two types: adrenergic and
cholinergic," is not a true statement. There are adrenergic and cholinergic
receptors.
Laura: Okay, so we know this is wrong and these are student generated
statements.
Angel: Yes
Laura: We can create letters for these.
Angel: Right
Laura: Cause we don't, we haven't seen this yet, right?
Angel: Right, not that I remember.
Laura: I don't remember seeing this. Cause even if they're referring to the
receptors or not this is just wrong.
Angel: Yes it's very wrong. And they are not looking at the incorrect
statements, they're not a whole lot of those actually.
Sympathomimetic effects...
Laura: I think all of these were that one map, right?
Angel: Sympatholytic effects...yeah.
Laura: That had them backwards.
Angel: ACH, yeah, ACH releases cholinergic norepi. Adrenergic...so they're not
specifically pointing back to receptor...neurotransmitters. So we can
make them new. Yup, they're new.
Laura: Alright.
Angel: "RR" so what's the first one?
Laura: Umm, "neurotransmitters two types adrenergic," so I guess we could
say "neurotransmitter one type adrenergic."
Angel: Mmmhmm. That is incorrect. And there is one of those.
Laura: And neurotransmitter one type cholinergic.
Angel: And that's "SS." Okay.
Laura: Alright, so. And you want to put a little note there like maybe in
parentheses that they might have been referring to these as receptors.
Like do you just want to make a note, err?
Angel: Even if they mean this as a receptor it's still an irrelevant statement.
Laura: Wrong, yeah. Do we want to notate it though, like?
Angel: Well sure, you can do that.
Laura: I mean, just put it in parenthesis or something like...the whole thing is
just curious to me. So maybe that's something to note is that in the

future maybe this master map should have the receptors on it cause clearly they seem to want the receptors to be on there.

Angel: And I deliberately didn't do that because it was so much.

Laura: Yeah

Angel: ...because we didn't have nicotinic, muscarinic, alpha, beta. We just didn't...

Laura: But they seemed, at least they seemed to wanted to have at least the adrenergic...

Angel: And I prevented that information...

Laura: ...they seemed to have wanted to include that.

Angel: Yeah connected.

Laura: Yeah.

Angel: Interesting.

Laura: Umm.

Angel: Okay.

Laura Misconception

Shock

[00:32:20.15] Angel is concerned that a student who appears to have an overall correct understanding of shock thinks that compensated shock is not a problem.

Angel: This is a false statement. "Compensated is adequate perfusion."

Laura: So M?

Angel: Yeah...it's similar to nine but, they're saying adequate and it's really not, it's compensating, I mean that's why it's compensated. It's umm you know what I mean. It's not really adequate perfusion. It's just bringing it back to baseline but there's still some...there's still a problem.

Laura: Well that student's demonstrating a misconception.

Angel: Yes, yes they seem to believe that when you're in compensated shock you're okay...is what that implies to me. It's adequate.

Laura: Yeah

Angel: And it's not, it's a return to baseline of that insult, whatever it may be. It's a temporizing measure. And they're not seeing that.

Laura: Okay, so it's a subtle wording difference that you're picking up on...

Angel: Well, particularly with some of the other statements.

Laura: They're not demonstrating that it's a problem.

Angel: Well, right. Because with some of the other statements they've made they are hitting absolutes and extremes.

Laura: Okay

Angel: That leads to organ failure, that equals for that, that equals that. So they are seeing a progression, but in this case, this seems, they're claiming that it's normal.

Laura: Mmmhmm

Angel: And that's not true.

Laura: Okay

Angel: Alright

This is a big deal to Angel, she doesn't over give the student credit when this can be a life-threatening mistake.

Angel Misconception

Angel Misconception
Shock
[01:22:11.26] Angel identifies a MAJOR shock misconception with a student and doesn't seem phased by it, she will just address it and it will be okay.

> Angel: Ooh this person has a problem. Interesting.
> Laura: Hmm
> Angel: And it's three.
> Laura: They got three?
> Angel: Uh huh
> Laura: Did you already tell me three or you just coded it?
> Angel: No
> Laura: Okay
> Angel: I just now did it. But look at what they did. So they have two types...
> Laura: Uh huh
> Angel: Shock uncompensated, this type of shock is irreversible.
> Laura: Huh
> Angel: So then they didn't talk about irreversible.
> Laura: Wow
> Angel: And that's wrong.
> Laura: Yeah
> Angel: And that's obviously something big we need to address with the
>   students because that's a big fallacy in their thinking.
> Laura: Wow
> Angel: So...
> Laura: They totally...
> Angel: Yeah, so this is LL?
> Laura: Yeah
> Angel: LL
> Laura: They think there's two types of shocks, not three.
> Angel: Yeah, right so that's what I'm saying this person has a big flaw in their
>   thinking.
> Laura: Wow
> Angel: It's okay, we'll fix it.
> Laura: [laughter]
> Angel: LL
> Laura: Okay

Formative assessment for her and views student misconceptions as fixable.

Angel Novice vs. Expert Overshadowing Laura Misconception
Cohort 1 ANS Analysis Part 1
[00:18:52.09] Identification of an overgeneralization misconception.
As Angel and I are a few propositions into coding the first student's map from the first cohort's autonomic nervous system maps we identify the first student generated proposition. Angel describes it as "overly simplified" while I am trying to get her to categorize it as a misconception.

> Laura: And then we have a sympathetic nervous system purpose is fight or flight.
> Angel: We didn't speak it like that. We spoke it in terms of a memory tool.
> Laura: Oh, so that actually is different. That is a unique idea.
> Angel: Yeah. The purpose is...
> Laura: Cause that's not exactly the purpose of it.
> Angel: Right
> Laura: Like it has many purposes.
> Angel: Well. But it's one thing that it does.
> Laura: It's, it's one purpose. It's not the only purpose. So it's...
> Angel: Huge spelling. Lots of spelling errors by this person.
> Laura: Oh, oh that is interesting. Umm...so would you consider that kind of like a misconception about it?
> Angel: Umm...
> Laura: Or I mean it's partially true, but it's...
> Angel: It's overly simplified. I don't think it's incorrect.
> Laura: So you would call it an oversimplification. So let's write this down as student generated.
> Angel: Okay
> Laura: We'll give it a letter. So we'll give this an A and we'll call it, we won't call that correct or incorrect. We'll call that an overgeneralization. Which is a type of misconception, by the way.
> Angel: Okay
> Laura: In the misconception literature.

When I ask Angel if she considers the proposition to be a misconception, her reply is "It's overly simplified. I don't think it's incorrect." I think Angel is using the terms "overly simplified" and stating that the student's proposition isn't incorrect to describe what she is interpreting as novice thinking. It is possible that Angel could be disagreeing with me here and just trying to use other words to say that she doesn't think it's a misconception. However I think it's much more likely that Angel is using her novice vs. expert interpretive lens here.

Angel Novice vs. Expert
Cohort 1 ANS Analysis Part 1
[00:28:11.16] AB notices student's superficial understanding of concept.
Angel describes how she likes seeing a student use the general term "has" in their proposition. She describes how it helps her understand her students better.

> Angel: I like their use of, I mean I don't like it, but I like their use of 'has.'
> Laura: Really?
> Angel: Yeah
> Laura: It's so general.
> Angel: Yes.
> Laura: It teaches you something about them.
> Angel: Well because yeah this is a deep concept and they're superficial. But the thing is, it has, it has sympathomimetic and sympatholytic, so it's an incomplete statement too.
> Laura: Mmmm, okay.
> Angel: But, but it's okay because then that would be another branch.
> Laura: Yeah, okay. I see what you're saying.

What Angel is describing that she likes here is the ability to notice that her student is superficially representing a deep concept. She goes on to describe how the student's representation is incomplete, but she likes it because the foundation is there for the student to build upon. Here Angel is using her novice vs. expert lens to interpret this student's map.

Angel Novice vs. Expert
Cohort 1 ANS Analysis Part 1
[00:42:36.13] Angel describes how she thinks differently about concepts from her students. The student went deeper than expected but also included redundant statements.

> Laura: So then...umm... "Adrenergic medications can also exhibit sympatholytic effects."
> Angel: And "sympathomimetic effects" those are both correct.
> Laura: Okay.
> Angel: And...where is it now, "adrenergic...sympatholytic..." I think they took it one step beyond. I think they went one step beyond.
> Laura: Really?!
> Angel: It's just an odd, it's quirky, but okay. Here.
> Laura: Huh.
> Angel: It's similar to what they did. But they said "adrenergic..."
> Laura: "Adrenergic medications can also exhibit sympatholytic effects."
> Angel: Huh...It's not untrue.
> Laura: [Laughter]
> Angel: I just don't...

Laura: This stuff is complicated.

Angel: Well I just don't think of it in those terms. That's all. It's not an untrue statement...what they're...but why it's weird or quirky...is because those terms are synonymous. Adrenergic and sympathetic are synonymous. That's where the use of the statement is a little twisted.

Laura: But look what they went on to do. "Block and stimulate alpha and beta receptors."

Angel: Yeah and again alpha and beta wasn't in the...

Laura: So they were really using this as a study tool.

Angel: Right. Right. And it's actually much deeper than I intended to...when we constructed the map, we just did the nervous thing, so it's actually a lot deeper than where we meant to go. But what's interesting here though is...this statement here "adrenergic medication can also exhibit sympatholytic effect."

Laura: Mmmhmm

Angel: Would be like saying capital A is the same as lowercase a, I mean it's a, it's a, what type of a statement is that? The relationship...

Laura: Redundant.

Angel: Yes. Yes.

Laura: Mmmhmm.

Angel: It's redundant.

Laura: But it's...

Angel: Now this though is good, but this is...what they're saying is adrenergic effects, you know, that these are the effects... but this is very good that it's beyond the scope of what we were asking them to do."

Laura: Well, let's catalog them, cause they appear to all be student generated.

Angel: Okay.

Angel is able to recognize the novice-like characteristics of this student while at that same time seeing that this student is excelling at the assignment.

Angel Novice vs. Expert
Cohort 1 ANS Analysis Part 1
[01:02:58.01] Angel describes how she is scared by the inclusion of a beta-blocker on this map, because it is irrelevant. Laura gives possible structural reasons for the student including the beta-blocker example on the map, since pharmacologically it isn't incorrect.

Angel describes how she is scared by a student's inclusion of an irrelevant proposition on their map. Angel states that her student's statement is correct then I posit an argument to the contrary. Angel then makes it very clear that what she is really more concerned about is that the content of the proposition has nothing to do with the assigned concept map. I pose an argument that perhaps the student went seeking the extraneous content to balance the symmetry of how they structured their map. Angel emphasizes how she barely taught some of the content in the student's map.

Angel: What scares me though is this...

Laura: Why?

Angel: That's a beta-blocker. Why is it even on there? Oh my goodness.

They're correct. "Neurotransmitters like labetalol exhibit sympatholytic effects." Cause it does block...labetalol is a beta-blocker...

Laura: But is it a neurotransmitter?

Angel: It's a drug.

Laura: But it's not a neurotransmitter.

Angel: I'm not aware of it being a neurotransmitter.

Laura: It's not natural, right?

Angel: Umm...

Laura: Or...

Angel: I don't think so...it's a medication.

Laura: Yeah

Angel: It's given to patients. And it is antiadrenergic. But again this is, this whole thing is, this whole thing is irrelevant, is another sidebar.

Laura: Mmm.

Angel: And...

Laura: Maybe they were...

Angel: This...

Laura: ...searching for something there.

Angel: Well this is a sidebar, but it is one that they will be required to learn. And obviously...[unintelligible]

Angel didn't teach this, it's irrelevant to the assignment, but Angel still finds something to like about it since they will have to learn it inevitably. Another novice argument.

Laura: Well maybe they were just searching for an actual balance. Is what it looks like. Maybe they figured there should be some natural balance. Like is there a natural beta blocker? I mean that the...that doesn't make any sense though. [laughter] That's interesting. Hmm.

Angel: You're nat...as far as I know the natural occurring beta, any beta blocking that's coming is through your renin and angiotensin and aldosterone and your fluid shifting, its not true beta blocking. But it's happening through the fluid shifting that's regulating your vascular sy...

Laura: So maybe they were just upset because

Angel: Well...

Laura: They had this nice organized chart and there was just this chunk missing and they were, they couldn't make sense out of it in their head, and they thought it needed these like symmetrical so they went researching.

Angel: Yeah, could be, could be

Laura: That's kind of what it looks like to me.

Angel: To balance it out.

Laura: Yeah, that's interesting.

Angel: I don't know that we're going to encounter it with anybody else.

Laura: I don't think we are going to, so I would say we just circle this whole thing. Okay.

Angel: This was beyond the scope of the presentation.

Laura: And I don't think we're going to encounter this with anybody else

either.

Angel: Right we didn't, we haven't done medications other than epi, norepi. And I, you know I talk to them about atropine on a very superficial level just to give them an illustration of something that has parasympatholytic effects, but it was just very superficial.

Laura: Okay.

Angel Novice vs. Expert
Cohort 1 ANS Analysis Part 1
[02:35:28.15] Angel notes the power of the pneumonic feed and breed based on its prevalence in the student's concept maps.

Angel makes the observation that her students are generating a lot of propositions connecting to the concept "feed and breed." She finds this striking because it is a slang term to her that is used as a memory tool.

Angel: Wow! So much about feeding and breeding here!

Laura: [laughter] People's favorite activities.

Angel: Well and it was, but it was slang. That's what's so strange about it. It's just a slangy... You know but it shows you the power of mnemonics, I guess. See we had it as a memory tool: fight or flight.

Laura: Yeah.

This is another example of Angel taking a novice vs. expert interpretive lens. She is describing how the pneumonic feed and breed must be powerful to the students or else they wouldn't use it so much. But at the same time, she is calling the pneumonic slang from her expert perspective and is surprised that her students are using the language so much in their concept maps.

Angel: But not causes, fight or flight stimulates parasympathomimetic or sympathomimetic but not sympathetic. We don't have that statement as you're saying it. We have the purpose as an overgeneralization. We have controls. I think, does that sound pretty good? SNS controls fight or flight? Causes? What do you think?

Laura: No cause it's "parasympathomimetic causes feed or breed."

Angel: Right and then "sympathetic causes fight or flight," right?

Laura: No, "sympathomimetic causes fight or flight." And then we have "fight or flight is the result of sympathetic." So we do have that: "fight or flight is the result of sympathetic."

Angel: Okay, SNS controls fight or flight, that's "S".

Laura: Okay and then...

Angel: PNS controls feed or breed, that's "V".

Laura: Okay

Angel: Okay, now what else?

But the overuse of feed and breed clearly does not bother her too much, she drops it and continues to analyze what they are actually saying.

Angel Novice vs. Expert
Cohort 1 ANS Analysis Part 2

[00:00:00.00] Angel describes how she views a map as a novice representation. It is nonsensical to her and I as experts, but it obviously made sense to the student or else they wouldn't have drawn it. I counter with the idea that possibly the student didn't even understand what they were drawing so their map doesn't even make sense to them.

Angel describes how a novice pattern of thinking can be non-sense to us as experts because we lose the ability to think like a novice. She goes on to describe how the students wouldn't have drawn their map this way if it didn't make sense to them as novices. I counter that perhaps that's not true, maybe the students drew a map that didn't make sense to them even. Angel's response to my counter-argument is a one-word brief polite agreement, said almost too fast to have even considered my statement. For reference, I've time-stamped the ending of the last word I said and the beginning of Angel's response. Only 13 hundreds of a second elapsed before Angel agreed.

> Angel: ...which is an expert from a novice. Is that novices or experts lose the ability to think like a novice.
> Laura: Yeah.
> Angel: I've actually heard that, you know, quite a bit. And you know this is obviously a novice pattern of thinking.
> Laura: Yeah.
> Angel: And if, and I look at it and you even look at it and although this is, this is, you're connecting this to other knowledge you already have you're looking at this going it doesn't make sense.
> Laura: Yeah.
> Angel: And I'm looking at it going it doesn't make sense. But obviously to them it made perfect sense or they wouldn't have coded it and put it on paper. And that's to them, that's a logical relationship.
> Laura: Maybe. Or there's the possibility that they didn't quite understand it and they drew it anyways. [00:01:03.07]
> Angel: [00:01:03.20] Right.
> Laura: Umm, okay so today is nine twentyeight and we're still coding the autonomic nervous system maps. And we forgot to put on the recorder to talk about umm we were discuss...

Again here Angel is displaying her novice vs. expert interpretive lens. It appears to be fairly resilient to my opinions and disagreement in this case as Angel appears to be only politely agreeing with my statement, not actually having thought about it or actually agreeing.

Angel Novice vs. Expert
Cohort 1 ANS Analysis Part 2
[01:01:05.16] Angel discusses how she focuses on trying to think like a novice since she has attended many meetings recently where discussions occurred about instructors not being able to think like a novice anymore.

Angel explains why she focuses on trying to think like a novice. She has been at some meetings and learned that experts have lost the ability to think like a novice. She has intentionally focused on thinking like a novice over the past few years as a result of

learning about this in meetings. Unfortunately though in the same moment she is not seeing the SMART method as a way to think like a novice, but instead seeing it as an assessment that will verify if she has been successfully thinking like a novice and teaching more productively as a result.

> Angel: Cause then that will kind of tell me and my thinking, cause I do often wonder about and I've been, I've been at a couple different meetings and things where that whole concept of we cease to be able to think like a novice.
>
> Laura: Yeah.
>
> Angel: And so I've kinda sorta refocused on that the last couple of years. Like how do they think about these concepts. And why is it so...
>
> Laura: A struggle.
>
> Angel: Well why is it something that is so blatantly obvious to us is such a big struggle for them, and I think if, I think one of the keys in helping, I don't know.

Angel Novice vs. Expert
Diabetes Analysis Part 2
[00:07:05.26] Angel brings up how she talked about being involved in this research at a faculty meeting recently and how valuable this research is to any instructor who has been teaching for more than 10 years. It allows her to see how the students are thinking like novices. Now instead of seeing a student choose an incorrect test answer and just being completely baffled by their answer, analyzing these maps is helping her to understand their thinking patterns. WOW WOW WOW!!! She can see that she is making assumptions that the students are making logical leaps that they clearly are not making.

Explicit novice expert
Flexibility of tools, allowing a national expert to think differently about her students.

> Angel: When I was speaking yesterday about your project in the division meeting. I'll put it on the tape for you now, but umm, yesterday at school, umm we were doing a celebration of the end of the semester. And umm our department chair asked us to each speak about our learning outcome projects and our teaching improvement projects and that's part of our requirement as faculty members we each have to be working on an approved teaching improvement or learning outcome every year.
>
> Laura: Uh huh
>
> Angel: And they don't have to be huge, they just have to be something that's showing that we're analyzing what we're doing and improving.
>
> Laura: Okay
>
> Angel: And so me talking about our project which is a formal research, you're working on your dissertation. Obviously its a big deal.
>
> Laura: Okay.
>
> Angel: I mean it was a big, big deal.
>
> Laura: Okay

Angel: Umm, but I was talking with the faculty members one of the things that I mentioned to them that this process has done for me is I said you know any of us that have been teaching for ten years or fifteen years or twenty years sometimes the students and maybe even other educators will tell us that we've lost the ability to think like a novice and to recognize what a novice is going through...

Laura: Mmmhmm

Angel: ...because we're content experts now and we've mastered it and so we sort of forget those struggles that we go through. But I said one thing that this project has done to help me with is going back and analyzing the students' this allows me to analyze the students' thought processes in a way I haven't been able to do before. And it really gives me a lot of insight because sometimes when they answer test questions and I walk away from that I think why did they pick that answer, that's ridiculous, you know.

Laura: Yeah

Angel: There's no way that answer is the correct answer, but then when I see their thinking processes illustrated here in the way they've shown me how they've made the connections, I can go back and go oh, now I, even though it's still flawed and wrong.

Laura: Yeah.

Angel: I can actually sort of see the path...

Laura: Uh huh

Angel: ...that they took to get to that wrong answer a little bit clearer. And it kind of helps me realize that I make assumptions that there con...making connections of logic that they're really not.

Laura: Mmm hmm

Angel: And so this has really helped, this you know analyzing that previous map and I'm sure with this one too it'll help me see how these are really complicated processes and its not an easy thing for them to get this the first pass. And that we need to keep trying to create ways that they can continue to manipulate this.

Angel Novice vs. Expert

Diabetes Analysis Part 2

[00:50:29.09] High blood glucose levels lead to diabetes, discussion of how naive this students statement is and incorrect.

Laura: "Blood glucose exceeding the normal limits will cause diabetes."

Angel: High blood glucose levels lead to diabetes. Superficial. It is very superficial. The high blood glucose level doesn't cause diabetes.

Laura: No, so the cause in there makes it incorrect.

Angel: That's what I'm saying, it's...

Laura: Yeah

Angel: It's a naive statement.

Laura: Yeah, if you interpret it totally correctly they are totally literally the cause makes it incorrect.

Angel: Right
Laura: That cause in there makes it incorrect.
Angel: They are not seeing cause and effect and they are not seeing that in
    several of their statements.
Laura: So you want to make this an "M?"
Angel: And it's an incorrect statement.
Laura: Okay, umm.

Angel Novice vs. Expert
Respiratory Meds Part 2
[00:15:18.29] Angel and Laura discuss a "nonsense student proposition." If you read it in the context of the propositions before this one then it makes a little more sense, but alone it makes no sense. Also the concept word conjugation needs to be changed to make complete sense.
Angel: Okay, this is a nonsense. "Bronchial smooth muscles causes
    bronchodilator." These this, all of these terms refer to the class of
    drugs, so bronchodilator is correct. This is a nonsense statement. So is
    that just "I" and its wrong?
Laura: Uhh, I think...I think they're in a very maybe perhaps they're saying in
    a very roundabout way that relaxation of the...
Angel: They already did that.
Laura: ...bronchial smooth muscles causes bronchodilation. [Unintelligible]
Angel: Well here the term is a drug.
Laura: Yeah
Angel: Bronchodilators cause bronchial smooth muscle what?
Laura: If you think it doesn't make any sense, yeah, I see what you're saying
    how they already said it relaxes it.
Angel: Yeah they already talked about that stuff, so I think that's just a
    nonsense so and the direction of the arrow its "bronchial smooth
    muscles causes bronchodilator" and that's a nonsense statement.
Laura: Maybe if you read the whole thing together, "beta-2 agonist relaxes
    bronchial smooth muscles causes bronchodilator."
Angel: But they meant bronchodilation. I'm sure.
Laura: Yeah
Angel: But they're talking about the drug class there.
Laura: Yeah
Angel: So then that makes all the rest of these wrong if you read that as...
Laura: Yeah
Angel: And a lot of these are right.
Laura: Yeah
Angel: So I think they just made a stupid connection.
Laura: Okay
Angel: So bronchial smooth muscles so that's an "I"
Laura: Mmmhmm
Angel: Bronchial smooth muscles causes and underline causes
    bronchodilator and that's incorrect. And it'll probably only show up

once, but...

Angel thinks this proposition is nonsense but she doesn't stay there, she recovers and still gives it a full analysis to see what could the student really be thinking. She gives full consideration of novice thinking.

Angel Novice vs. Expert
Respiratory Meds Part 2
[00:19:54.19]Angel notes that this student phrased things correctly, but they kind of went in different directions from her (Map 1).
>Angel: So they phrased things oddly. And they kind of went different directions from me and the thought processes but they had a lot of correct things to say.
>Laura: Okay
>Angel: And this is map one.
>Laura: Okay.

View of novices, stable view, didn't go awry from novice view. Different from her isn't necessarily a bad thing.

Angel Novice vs. Expert
Respiratory Meds Part 2
[00:50:39.17] Angel describes a students proposition as nonsense. But again she goes on to pick it apart to understand what the student really meant.
>Angel: "Beta-2 agonist if it binds to multiple sites is non-specific beta-agonist." It's that's a non-sense statement. Beta-2s are specific, non-specific betas are not beta-2s, so...
>Laura: I think they're saying there that a beta, a non-specific beta agonist is...oh yeah that doesn't make any sense.
>Angel: Unless they're trying to say that...
>Laura: ...that it's related to a beta-2...
>Angel: ...if it's, it's either, I don't know if they're saying it's an either or statement...
>Laura: Maybe
>[microwave popcorn & strawberry interlude]
>[00:54:53.25]
>Angel: "Beta-2 agonist non-specific if it binds to multiple sites its called non-specific," but beta-2 agonists are not non-specific. So that's why this is difficult. Beta-2 agonists bind to beta-2 sites.
>Laura: Mmmhmm
>Angel: Non-specific beta agonists could have cardiac or respiratory cause they could be beta-1 or beta-2 binding.
>Laura: Yeah
>Angel: So is it an "AA?"
>Laura: I don't, I mean sure.
>Angel: Okay. And it's incorrect. It's partially correct, it's close, but it's not.

> Had they made it two statements they probably would have had it right.
>
> Laura: So it's beta-2 agonist...
>
> Angel: Mmmhmm
>
> Laura: And then where do you want the middle to be?
>
> Angel: If it binds to multiple sites...and that should be underlined. Non-specific beta agonist.

Almost anyone would write this off, but Angel dug deeper and tried to understand.

Angel Novice vs. Expert
Respiratory Meds Part 2
[01:25:54.28] Angel notes that the student did a pretty good job on their map, they just went at the differently than us.

> Angel: This person did a pretty good job, they just spoke at it differently than we would. But they spoke a lot of truths. You know what I mean?
>
> Laura: Yeah

Angel Novice vs. Expert
Respiratory Meds Part 2
[01:35:15.28]Angel notes the map is very linear. Laura discusses the duplicate propositions in the map. Angel describes how this map was very simplistic. She predicts not much thinking about the concepts.

> Angel: Very linear.
>
> Laura: I wonder if the duplicate concepts like in that case that duplicate concept almost looks like they weren't like paying attention. Like it looks like it was done in, like that duplicate concept looks like haste you know whereas the other duplicate concept in the really complicated map that we saw that looked like the map was so complicated...
>
> Angel: Right, they respoke...
>
> Laura: ...that they didn't even realize.
>
> Angel: well or they respoke it.
>
> Laura: Yeah
>
> Angel: It's like they first talked about bronchodilation.
>
> Laura: Mmmhmm
>
> Angel: And then they talked about receptors and they talked about targeting of the receptors, so the natural endpoint to some of those receptor targets is bronchodilation so you could see how that would come out a couple times because of the layers.
>
> Laura: Yeah
>
> Angel: Yeah, but this one yeah it's very simplistic.
>
> Laura: Mmmyeah
>
> Angel: Everything, there was basically two levels here. Everything coming into bronchodilation they just had the classes.
>
> Laura: Mmmhmm

Angel: And then they just gave you a couple examples of each of them, but this one they decided to talk about the bronchial smooth muscle relaxation. And this one just gave you the subclasses.

Laura: Mmmhmm

Angel: So and then this effects that receptor and its a mineral. And I mean this is very much a one trick pony do it in five minutes.

Laura: Yeah

Angel: To turn it in for a grade map versus a conscious thinking of the relationships and you know...

Laura: Yeah

Angel: ...doing some depth analysis.

Angel's is viewing this student as a novice and her view of novice includes grade-seeker, just trying to get the certification, not yet understanding why they need to know everything in depth. (NEW Category or Sub) Catch 22, learners must understand big picture to known why they need to understand all of the details, but they must know a lot of the details to understand the big picture. So they are iteratively learning both, slowly gaining expertise as they are theoretically gaining an appreciation for why that expertise is so important. Novices can't even truly grasp why the expertise is valuable yet other than is isolated extrapolated circumstances.

Angel Novice vs. Expert
Shock
[01:35:08.10]

Laura: So how do you want to word it?

Angel: I don't know. Low blood pressure is...equals shock, I guess. I mean that's how I'm reading this. Shock BP lowers blood pressure. Blood pressure lowers shock. Shock lower...they're saying that...am I reading too much into it?

Laura: I think that they're trying to say that like low blood pressure...

Angel: ...equals shock.

Laura: ...equals shock.

Angel: Yeah and that's what I'm seeing there too. That's fine. That's what I'm seeing.

Laura: So you don't want to code that though as umm...low BP is a late sign of shock?

Angel: No, cause it's that quantifies it more than what I think...

Laura: Okay

Angel: ...this student did. They're making it a broader statement. I think that one's more narrowed.

Laura: Okay, okay.

Angel: See I don't even know what the connection is here. Cause it...man this is really jumbl..., it's really not...I'm gonna run to the restroom...

Laura: [laughter]

Angel: ...think on it. You can think on it while I'm gone...

Laura: Okay

Angel: ...cause it's very jumbled thinking. And it's kind of all over the place.
[01:37:02.11]
[01:39:48.12]
Laura: This is rough. I kind of...
Angel: [unintelligible] stuff, isn't it?
Laura: I kind of see a thought process here but it's hard... They're umm
    they're trying to like...
Angel: ...make connections...
Laura: ...go down and up on both sides.
Angel: Yeah
Laura: A little bit, they're trying, like there is some work in here.
Angel: Uh huh
Laura: It's just...I think they really struggled. Or didn't put a much time and
    ener..., I mean when I see things like this...
Angel: Yeah, I don't like to...
Laura: I'm pained.
Angel: Well I don't like to assume that they didn't put any effort into it cause
    we don't know
Laura: Well, honestly when I read the surveys on average they all spent less
    than a half hour on these.
Angel: Oh, so okay they're not.
Laura: Which is very inappropriate for a concept map of this complexity.
Angel: Right
Laura: I want to be seeing an hour at a minimum. Cause think about how long
    it took us...
Angel: Well remember these are the same...
Laura: ...to build these.
Angel: Well, agreed, these are the same students who go through a seventy
    question multiple choice test with four answer choices fifty words roughly
    each question in twelve minutes. Yeah, so...
Laura: Umm why don't you look at that for a few minutes.
Angel: You're gonna go to the bathroom, now.
Laura: Yeah, I've gotta go [laughter]
Angel: Okay

Angel's Thinking About Novices

Angel's Thinking About Novices
Cohort 1 ANS Analysis Part 2
[01:02:20.00] Angel talks about how the process of struggling helps with growth. Talks about metaphors for helping a chick hatch and butterfly emerge. She talks about how it is difficult to find the balance between allowing students to struggle enough to make their own connections, but not making it so hard that they lose engagement.

Helps define for what a novice is for Angel.

234

Angel: It's like you know like when you're watching a chick hatch. Have you ever done that? Actually seen one really hatch? If you grow up on a farm your parents will tell you very quickly you don't help them out of the egg shell because if you actually get in there and pick and help them emerge out of the egg.

Laura: Mmmhmm

Angel: A lot of times they'll die.

Laura: Why?

Angel: It's there's something that's going on physiologically in the act of breaking out...

Laura: Uh huh

Angel: That you know it's kind of like a butterfly when it, when it comes out, its that struggle to get out is what gets the circulation going and it gets their wings expanding and then they can fly.

Laura: Uh huh

Angel: And if you ever would get in to a chrysalis and like you see one emerging and you want to help it a little bit the wings won't expand and they won't fly, they won't be able to fly. It's like it kills them, the act of the struggle is actually what allows them to become what they're gonna be. And so some of this I don't know if it's really appropriate for us to help them make connections always. Sometimes its like you have to let them struggle through that and sort of encourage that they're on the right track without actually correcting their errors. And then let them kind of come to their own understanding in the end.

Laura: Hmm

Angel: And that's what I find fascinating about education really is trying to find out what that right mix is, not so much that you, it frustrates them to quit, but its enough for them to stay engaged in them wanting to know instead of you handing it to them.

Laura: Yeah

Angel: So

Laura: I didn't know this

Angel: Yeah

Laura: The chicks and the butterflies...

Angel: Yeah, yup it'll kill them.

Laura: Hmm

Angel: It's very interesting, yeah it's something about the struggle that makes them what they are. Pretty cool, huh?
[laughter]

Angel's Thinking About Novices
Cohort 1 ANS Analysis Part 3
[01:08:04.16] Angel describes how she is torn between helping the students make connections and allowing them to work through the learning on their own.

235

Constructivist, this is how she thinks about novices.

> Angel: I'm just always kind of torn, I go back and forth a lot between actually sitting down and connecting the dots for them...
>
> Laura: Mmmhmm
>
> Angel: ...or having them dig and this level, at this level of learner...
>
> Laura: Mmmhmm
>
> Angel: ...I find them to be very dependent although this class has not been very argumentative...
>
> Laura: Mmmhmm
>
> Angel: ...about things. But I find them to be very dependent of, they sort of want me to connect dots for them instead of them connecting themselves. So they don't come in and engage me in questions about well gosh I read this and I didn't quite understand what it meant, you know my big thing is, well did you know and of course they're not gonna be honest about this, but raise your hand if you read the chapter. You know.
>
> Laura: Yeah
>
> Angel: And that's kind of, and then they'll passively although they do get engaged but they'll relatively fairly passively sit in class. I can do application pieces afterward which I've been trying to do and I do more of where we'll sort of I'll talk about a topic and then we'll immediately apply it. But a lot of and they will discuss it and they will enjoy doing those kind of things, but a lot of the things are they haven't laid a good foundation yet.
>
> Laura: Mmmhmm
>
> Angel: So they're not really getting all of the stuff out of that they would had they laid a foundation before they walked in the door. So then I have to just hope and trust that then they go home and they read the chapter.
>
> Laura: Okay
>
> Angel: But when they go home they go, well I've already got everything I need, I don't need to read the chapter now.
>
> Laura: Mmm
>
> Angel: And then I move on into the next phase of the class.

Angel's Thinking About Novices
Cohort 1 ANS Analysis Part 3
[01:23:10.18] Angel is interested in the areas on the map where the students are weak. She didn't prompt connections, but she thinks they could have been prompted to think deeper and put more effort into their maps.

Two possibilities: 1) Students are smart, if task doesn't show, must reframe. 2) I taught students these ideas so they must have learned them, I must not have elicited them properly. Hammer & Elby work on multiple teacher beliefs. I argue based on her final comments that she is the second possibility here. More about views on novices?

> Angel: I think its interesting to see where they are weak, like this idea of

these being branches of each other.

Laura: Mmmhmm

Angel: But they, but some of them I guess this represents maybe three or two students.

Laura: It's two.

Angel: Two, recognized that its also known as.

Laura: Mmmhmm

Angel: So they are seeing the relationship its just that when we ask them to express it, it wasn't easily coming out.

Laura: Yeah

Angel: Now I didn't clue them in to umm making connections but I have a feeling if I would have pushed them and suggested like when we counted it up we saw that at least two things connected to each thing.

Laura: Mmmhmm.

Angel: I think if we would have expressed to them umm that each of these concepts will have at least two connections.

Laura: Mmmhmm

Angel: That might have framed it for them and kind of given them a little push to dig a little deeper. Because I think a lot of those maps were the example of umm...

Laura: Not...

Angel: ...superficial effort as a secondary thing.

Laura: Hmm

Angel: I mean a lot of students in the, at this level...

Laura: Okay

Angel: ...its very much driven by sort of stimulus responsey kind of stuff, like I will do the work that is being graded, I don't typically do a lot of stuff outside of what is being graded because I'm still a fairly dependent on the instructor feedback kind of a learner. And so there are few people in my program that I have ever had...

Laura: Mmmhmm

Angel: ...that will spontaneously go and read something. Now it has been a pleasant surprise over the years when I've like mentioned a book or something and then the next thing I know one of the students comes in and they're you know showing me that they're reading that book. That's the exception, not the rule.

Laura: Okay.

Angel's Thinking About Novices
Diabetes Analysis Part 2
[00:56:47.28] Angel says the map is a student's who drew it 2 minutes before the exam just to get credit. She is basing this off the superficiality of the map (earlier statements).

Laura: Oh, this is a handwritten ones. Umm "Hypertension can cause atherosclerosis."

Angel: We didn't go that direction.

Laura: I don't see it on here either.

Angel: We actually, and it's actually not really true, atherosclerosis causes hypertension so it's an incorrect statement. [Yes, thank you very much!]

Laura: Okay, umm. "Hypertension is a type of cardiac disease."

Angel: Mmmuh, don't even.

Laura: Would you even consider hypertension a type of cardiac disease?

Angel: It contributes to it.

Laura: I wouldn't consider it a type of though.

Angel: No, I wouldn't either. This is somebody who drew something two minutes before the exam because they wanted to get the twenty-five points for turning it in. That's what this is, guaranteed.

Looks for other explanations for student incorrectness.

Angel's Thinking About Novices
Respiratory Meds Part 2
[00:15:18.29] Angel and Laura discuss a "nonsense student proposition." If you read it in the context of the propositions before this one then it makes a little more sense, but alone it makes no sense. Also the concept word conjugation needs to be changed to make complete sense.

Angel: Okay, this is a nonsense. "Bronchial smooth muscles causes bronchodilator." These this, all of these terms refer to the class of drugs, so bronchodilator is correct. This is a nonsense statement. So is that just "I" and its wrong?

Laura: Uhh, I think...I think they're in a very maybe perhaps they're saying in a very roundabout way that relaxation of the...

Angel: They already did that.

Laura: ...bronchial smooth muscles causes bronchodilation. [Unintelligible]

Angel: Well here the term is a drug.

Laura: Yeah

Angel: Bronchodilators cause bronchial smooth muscle what?

Laura: If you think it doesn't make any sense, yeah, I see what you're saying how they already said it relaxes it.

Angel: Yeah they already talked about that stuff, so I think that's just a nonsense so and the direction of the arrow its "bronchial smooth muscles causes bronchodilator" and that's a nonsense statement.

Laura: Maybe if you read the whole thing together, "beta-2 agonist relaxes bronchial smooth muscles causes bronchodilator."

Angel: But they meant bronchodilation. I'm sure.

Laura: Yeah

Angel: But they're talking about the drug class there.

Laura: Yeah

Angel: So then that makes all the rest of these wrong if you read that as...

Laura: Yeah

Angel: And a lot of these are right.

Laura: Yeah

Angel: So I think they just made a stupid connection.
Laura: Okay
Angel: So bronchial smooth muscles so that's an "I"
Laura: Mmmhmm
Angel: Bronchial smooth muscles causes and underline causes
    bronchodilator and that's incorrect. And it'll probably only show up
    once, but...

Angel thinks this proposition is nonsense but she doesn't stay there, she recovers and still gives it a full analysis to see what could the student really be thinking. She gives full consideration of novice thinking.

Angel's Thinking About Novices
Respiratory Meds Part 2
[00:28:22.03]Laura and Angel discuss how this student's map creates run-on propositions. They are trying to decide how to code it. Laura thinks they are overinterpreting the map. Angel thinks that they can interpret that the student has lots of incorrect ideas.
Angel: "Bronchodilation stimulates bro"...oh so this is probably
    "bronchodilation occurs by stimulating bronchial smooth muscles."
    Right? "Sedatives decrease bronchodilation by stimulating bronchial
    smooth muscles." "Nonspecific beta agonist increases bronchodilation
    by stimulating bronchial smooth muscles." So are these more
    statements?
Laura: Probably, that's probably how they're supposed to be read.
Angel: "Parasympatholytic decreases bronchodilation by stimulating
    bronchial smooth muscles."
Laura: That's probably how they're supposed to be read.
Angel: Yeah and that would be false, that whole statement is false.
Laura: Mmmhmm
Angel: "Sedatives decrease bronchodilation by stimulating bronchial smooth
    muscles." False. "Neuromuscular blocking agents decrease
    bronchodilation by stimulating bronchial smooth muscles." False. So
    the, those extra statements, there's three more there...
Laura: [laughter] Oh man!
Angel: It's "V," "W," "X." But then this one could go through there through
    that pathway as well. This one could go through that pathway. This
    one could go through that pathway. That one...all of them.
Laura: So we don't have, al... so okay so when we, when we do this we don't
    end up with these gigantic long compound sentences...
Angel: Right
Laura: ...cause we could connect everything too.
Angel: No
Laura: But we don't.
Angel: But I mean this one looks like it is. In that case it looks like they did
    that. I'm fine with not coding it, personally, I mean I don't know if we

want to you know like you've done in the past, circle a section.

Laura: Umm

Angel: There were so many errors in their thinking anyway.

Laura: Have we coded everything in there that's correct?

Angel: Uh yeah

Laura: Okay, tell you what...

Angel: Ten, eleven...

Laura: ...you've marked everything on there that's been coded right?

Angel: Everything in here has been coded. We had two...

Laura: Except for what?

Angel: Two, ten, and eleven. This is the only place that we haven't coded anything but it looks like everything runs through that to get to here. "Bronchodilation by stimulating bronchial smooth muscles." So "corticosteroid is a beta-2 agonist effects bronchodilation by stimulating bronchial smooth muscles." "Magnesium sulfate used for bronchodilation by stimulating..." It just looks like they all run through that sen...you know how when you play that game with fortune cookies and you put "in bed" at the end of it.

Laura: [laughter] Yeah

Angel: That's what they've done here, they done an "in bed" with the end of everything and it run...it stops at bronchodilation.

Laura: Mmmhmm

Angel: And then its "in bed." [laughter] And that's what they it looks like they've done here in their thinking.

Laura: Okay, but here like let's look at this, "beta-2 agonist affects bronchodilation."

Angel: Mmmhmm

Laura: So that's correct and we were able to code that.

Angel: Yes. There were two places where that occurred. Here and here.

Laura: Yeah, so...

Angel: Everything else is a letter...

Laura: The rest of their thinking...

Angel: ...and most of them are wrong.

Laura: Yeah, so I don't think, I think what we're doing here is we're really struggling to try to show maybe that this student isn't as incorrect as you [laughter] as we're seeing maybe.

Angel: Well it's not that, I'm just saying that their statements, they compounded their statements like you said.

Laura: Mmmhmm

Angel: But it looks like they've tried to you know there's two parts to it. Bronchodilation is the first wall.

Laura: Mmmhmm

Angel: And then from the bronchodilation this is almost like its the end of the statement on every single one of them. And the thing is, if it was wrong here, it followed through that it was wrong the whole time.

Laura: Okay

Angel: So, this one was a correct statement all the way through.
Laura: Mmmhmm
Angel: This one was a correct statement all the way through and everything else was either correct or incorrect. What did you get for umm "H" and "K" and "N" and then we created all these other ones that they just pulled out of their behinds which were I think mostly incorrect weren't they?
Laura: Mmmhmm, yeah, so this student has...
Angel: "R," "S," "T," and "U."
Laura: "P" and "Q" that are correct.
Angel: And that was a sympathomimetic increasing the heart rate. And again we didn't say anything about cardiac stimulation, we kept it all in the realm of what happened with the bronchioles.
Laura: Mmmhmm
Angel: Because I felt when we were coding this that it was adding to much in...
Laura: Mmmhmm
Angel: ...to talk about the cardiac effects.
Laura: Mmmhmm
Angel: So they went and talked about cardiac effects and got some of them right but several of them wrong.
Laura: And this is the respiratory med concept map.
Angel: Right and we cover cardiac in January. So I'm fine with stopping this one here.
Laura: I guess just circle it, yeah.
Angel: Yeah
Laura: Okay, so we've been talking about map number two in respiratory meds. Okay, yeah.

[00:34:24.24]
Angel spent a long chunk of time making sense out of this student's ideas instead of assuming they were senseless. Partly the SMART game and partly a very productive aspect of SMART for instructors to understand their students better. Could have circled and not coded this part, but wanted to understand this.

Angel's Thinking About Novices
Respiratory Meds Part 2
[00:48:59.01]Angel notes that she is driven crazy by students including things like "we have two lungs" in their maps. But she goes on to explain how the student probably included it as part of the memory tool that she taught them about beta-2 agonists. But she also thinks their correct extrapolation to methylxanthines having cardiac effects is a little too much.
Angel: [sigh] This drives me nuts! How many lungs do we have? Two!
Laura: [laughter]
Angel: Beta-2 agonist that's a memory trick. So is that "AA?"
Laura: So they thought that methylxanthine could affect the lungs and the heart...

Angel: Yeah
Laura: Is what they said?
Angel: Yeah
Laura: But it doesn't it only affects the lungs.
Angel: Well no methylxanthines can have cardiac affects, that's nothing that we taught them though and it's just...caffeine is a methylxanthine.
Laura: Okay so it is correct.
Angel: Well yeah but where did they learn that factoid?
Laura: Maybe they were thinking about caffeine.
Angel: You give them too much credit. Alright so...
Laura: [laughter]
Angel: ..."beta-2 agonist how many lungs so we have two." I think they are using the number two as a memory aid they're using having two lungs as a memory aid for beta-2 agonist cause that's the thing I teach them to you have one heart and two lungs. You have beta-1 and beta 2.
Laura: Mmmhmm
Angel: So that's what they've reconstructed there, I think.
Laura: Okay
Angel: ...is that memory tool.
Laura: Okay
Angel: That wasn't a part of this, so is that "AA?"
Laura: Do you want to just, eh uh, let's just circle it for now and if we don't see it anywhere else.
Angel: Okay
Laura: It's kind of odd.
Angel: Yes. Very odd. Okay

Angel's gut is this is simplistic, but then she realizes that they are just including her memory tools for beta-1 & 2 agonists.

Angel's Thinking About Novices
Respiratory Meds Part 2
[00:50:39.17] Angel describes a student's proposition as nonsense. But again she goes on to pick it apart to understand what the student really meant.
Angel: "Beta-2 agonist if it binds to multiple sites is non-specific beta-agonist." It's that's a non-sense statement. Beta-2s are specific, non-specific betas are not beta-2s, so...
Laura: I think they're saying there that a beta, a non-specific beta agonist is...oh yeah that doesn't make any sense.
Angel: Unless they're trying to say that...
Laura: ...that it's related to a beta-2...
Angel: ...if it's, it's either, I don't know if they're saying it's an either or statement...
Laura: Maybe
[microwave popcorn & strawberry interlude]
[00:54:53.25]

Angel: "Beta-2 agonist non-specific if it binds to multiple sites its called non-specific," but beta-2 agonists are not non-specific. So that's why this is difficult. Beta-2 agonists bind to beta-2 sites.

Laura: Mmmhmm

Angel: Non-specific beta agonists could have cardiac or respiratory cause they could be beta-1 or beta-2 binding.

Laura: Yeah

Angel: So is it an "AA?"

Laura: I don't, I mean sure.

Angel: Okay. And it's incorrect. It's partially correct, it's close, but it's not. Had they made it two statements they probably would have had it right.

Laura: So it's beta-2 agonist...

Angel: Mmmhmm

Laura: And then where do you want the middle to be?

Angel: If it binds to multiple sites...and that should be underlined. Non-specific beta agonist.

Almost anyone would write this off, but Angel dug deeper and tried to understand.

Angel's Thinking About Novices

Shock

[00:17:10.26] Angel doesn't like how a student used the word determines for a majority of their propositions linking words. They also didn't give directionality to their propositions. Despite this she still manages to assign a lot of instructor predicted proposition codes to the students map.

Angel: I don't like the use of the word determines here.

Laura: A lot on that map, look...

Angel: They did it all...

Laura: ...how many times determines is on there.

Angel: ...all the time. Yeah it's constant... Nineteen times. And then they have two causes and three is's.

Laura: Mmm

Angel: And there is not a whole lot of arrows showing directionality either.

Laura: Mmmhmm

Angel: But we'll try to figure it out. 22...see again they're not talking about...directionality, they're not talking about negative or positive, they're just saying it determines it. But they have connected decompensated to perfusion. We have decompensated is caused by decreased perfusion. Decompensated determines perfusion, perfusion determines decompensated, there's no arrow. 23...3...15...9...14...7...6...I like this where, use of determines, 24...

Laura: Makes it hard to tell if they understand it or not.

Angel: Yeah, I don't think, I mean they do, they know it's connected...

Laura: Yeah

Angel: But they don't know directionality very well cause they haven't

243

expressed it.

Laura: It makes it hard to tell, it almost looks like they did it very fast, so it's hard to tell like, it's hard to tell their level of understanding. Looks like they didn't put much thought into it, they just slapped the same word in their repeatedly. And they have a lot of connections, which...

Angel: 17...2...19...4...yeah I think that's all I could capture.

Laura: Okay

Commitment to understand students map.

Angel's Thinking About Novices

Shock

[00:32:20.15] Angel is concerned that a student who appears to have an overall correct understanding of shock thinks that compensated shock is not a problem.

Angel: This is a false statement. "Compensated is adequate perfusion."

Laura: So M?

Angel: Yeah...it's similar to nine but, they're saying adequate and it's really not, it's compensating, I mean that's why it's compensated. It's umm you know what I mean. It's not really adequate perfusion. It's just bringing it back to baseline but there's still some...there's still a problem.

Laura: Well that student's demonstrating a misconception.

Angel: Yes, yes they seem to believe that when you're in compensated shock you're okay...is what that implies to me. It's adequate.

Laura: Yeah

Angel: And it's not, it's a return to baseline of that insult, whatever it may be. It's a temporizing measure. And they're not seeing that.

Laura: Okay, so it's a subtle wording difference that you're picking up on...

Angel: Well, particularly with some of the other statements.

Laura: They're not demonstrating that it's a problem.

Angel: Well, right. Because with some of the other statements they've made they are hitting absolutes and extremes.

Laura: Okay

Angel: That leads to organ failure, that equals for that, that equals that. So they are seeing a progression, but in this case, this seems, they're claiming that it's normal.

Laura: Mmmhmm

Angel: And that's not true.

Laura: Okay

Angel: Alright

This is a big deal to Angel, she doesn't over give the student credit when this can be a life-threatening mistake.

Angel's Thinking About Novices
Shock
[00:57:10.28] Laura is interested in the students putting the stroke volume equation on their maps. Angel is not and is actually more interested in the other things that these students are putting on their maps.

> Laura: Do you wanna since two people have actually put the equation on here do you want to create a student generated concept for people demonstrating that equation? Yeah cause it's on the map.
>
> Angel: I don't care.
>
> Laura: Do you want to see if anybody else does it? I think that's kind of neat that people have demonstrated that equation.
>
> Angel: Well I beat em, I beat it into their heads. Wow. Here's another one. Heart rate plus stroke volume equals cardiac output.
>
> Laura: I think we should do that cause that's neat that they thought to do that.
>
> Angel: Okay
>
> Laura: I think that's neat. I've never seen somebody put an equation in a concept map.
>
> Angel Oh yeah?
>
> Laura: Yeah, I think that's a neat way of, I think that's neat.
>
> Angel: Okay
>
> Laura: I would like to code that. Let's make that Z.
>
> Angel: Here's another one. Stroke volume multiplied by heart rate creates a cardiac output.
>
> Laura: Yeah let's code that.
>
> Angel: Okay, so we go back.
>
> Laura: Yeah, I think it was only on one other map. But let's give that letter Z and...yeah it was right there. Yeah so just like circle it or something. Where it appeared on the map.
>
> Angel: So Z is the stroke volume equation. So don't make it seven and eight, or go ahead and keep it as seven and eight?
>
> Laura: It's also that, but I think it's....
>
> Angel: So this is Z.
>
> Laura: Yeah I think it's neat that they're actually attempting to demonstrate an equation in the map.
>
> Angel: Well on this one it's really gone kind of deep because they're talking about baroreceptors and everything. And uh, that's great that they did that. And then at this other one here is nothing but receptors which is gonna be hard to code because it's all off the map.
>
> Laura: Okay
>
> Angel: All off what we said.
>
> Laura: Okay
>
> Angel: But okay...

Is there more evidence that this is the type of stuff that she doesn't care about because it's too trivial? Interview confirmation?

Angel's Thinking About Novices
Shock
[01:33:36.29] Angel notices that we didn't include a proposition on our map that we should have. She describes a student's map as jumbled thinking. Angel defends amount of time student may have spent on the map, Laura contradicts with surveys. Angel describes how medicine is not black and white but gray and it's hard for students to recognize that. Angel describes how students struggle to recognize subtle trends.

Angel: That is so weird that we didn't make any connection between blood pressure and shock [laughter] that's just weird.
Laura: [laughter]
Angel: Umm, so we have that in there somewhere cause one of the students said it. Shock uh blood pressure and...uh lower...
Laura: Shock is directly related to blood pressure or more specific...
Angel: Well shock BP lowers blood pressure.
Laura: Low BP is a late sign of shock.
Angel: No, low blood pressure equals shock basically is what this says.
Laura: All we have is low BP is a late sign is shock.
Angel: Okay, well then this is a new one.
Laura: Okay
Angel: Umm
Laura: RR
Angel: Yeah...umm...
Laura: So how do you want to word it?
Angel: I don't know. Low blood pressure is...equals shock, I guess. I mean that's how I'm reading this. Shock BP lowers blood pressure. Blood pressure lowers shock. Shock lower...they're saying that...am I reading too much into it?
Laura: I think that they're trying to say that like low blood pressure...
Angel: ...equals shock.
Laura: ...equals shock.
Angel: Yeah and that's what I'm seeing there too. That's fine. That's what I'm seeing.
Laura: So you don't want to code that though as umm...low BP is a late sign of shock?
Angel: No, cause it's that quantifies it more than what I think...
Laura: Okay
Angel: ...this student did. They're making it a broader statement. I think that one's more narrowed.
Laura: Okay, okay.
Angel: See I don't even know what the connection is here. Cause it...man this is really jumbl..., it's really not...I'm gonna run to the restroom...
Laura: [laughter]
Angel: ...think on it. You can think on it while I'm gone...
Laura: Okay

Angel: ...cause it's very jumbled thinking. And it's kind of all over the place. [01:37:02.11]

[bathroom break]

[01:39:48.12]

Laura: This is rough. I kind of...

Angel: [unintelligible] stuff, isn't it?

Laura: I kind of see a thought process here but it's hard... They're umm they're trying to like...

Angel: ...make connections...

Laura: ...go down and up on both sides.

Angel: Yeah

Laura: A little bit, they're trying, like there is some work in here.

Angel: Uh huh

Laura: It's just...I think they really struggled. Or didn't put a much time and ener..., I mean when I see things like this...

Angel: Yeah, I don't like to...

Laura: I'm pained.

Angel: Well I don't like to assume that they didn't put any effort into it cause we don't know

Laura: Well, honestly when I read the surveys on average they all spent less than a half hour on these.

Angel: Oh, so okay they're not.

Laura: Which is very inappropriate for a concept map of this complexity.

Angel: Right

Laura: I want to be seeing an hour at a minimum. Cause think about how long it took us...

Angel: Well remember these are the same...

Laura: ...to build these.

Angel: Well, agreed, these are the same students who go through a seventy question multiple choice test with four answer choices fifty words roughly each question in twelve minutes. Yeah, so...

Laura: Umm why don't you look at that for a few minutes.

Angel: You're gonna go to the bathroom, now.

Laura: Yeah, I've gotta go [laughter]

Angel: Okay

Laura: I'll be back in a minute.

Angel: We could skip this map and come back to it.

Laura: I mean we can but...

Angel: I mean there's only one more. [01:41:56.24]

[bathroom break]

[01:46:44.23]

Laura: Sorry that took long, I saw people I knew.

Angel: That's okay. Yeah, next time I added this.

Laura: Oh cool

Angel: And then we'll have to put a number in for it.

Laura: [unintelligible] shock

Angel: ...is low blood pressure.

Laura: equals blood pressure, okay.

Angel: And organ failure leads to death. We've seen that a couple times too but...

Laura: Okay

Angel: And then there's the equations

Laura: Okay

Angel: So it's the output, heart rate stroke volume equals output. Heart rate stroke volume vascular resistance equals blood pressure output times vascular resistance, I taught them all three.

Laura: So how you put two blood pressure equations and the cardiac output equation.

Angel: Yeah we've got two. Two ways of expressing it.

Laura: Alright. Okay.

Angel: So

Laura: Cool, awesome.

Angel: Yeah and I'm not sure because again with that being like that I'm not sure how you add that in without doubling up on the words which you don't want to do and I think that maybe that's why we didn't put them in.

Laura: I don't necessarily think we need to add them in, I think its a neat phenomena that they added them in.

Angel: Uh okay.

Laura: That's what I thought...

Angel: So maybe we put that as part of the key or something for the next time. But this is something I'm seeing that I want to reinforce with each of them, more physiology.

Laura: Okay

Angel: Which I think is actually cool they're getting it but some of them aren't quite getting it all.

Laura: Okay

Angel: For example the one who didn't make the connection that there's three types.

Laura: Okay

Angel: So that'll be something to emphasize. And I kind of like to do that with some scenario things.

Laura: Mmm

Angel: Like here's some vital signs and make them vague...

Laura: Okay

Angel: ...in some cases, make them obvious in others. But make some of them vague so they actually have to declare what they think it is.

Laura: Okay

Angel: You know cause the patient's aren't always completely black and white, it's those shades of gray. And I think that that'll help drive home the idea that decompensation is the transitional stage.

Laura: Yeah

Angel: And you've got the compensated who can fairly easily recover with the

right support.

Laura: Yeah

Angel: And then you've got the irreversible, which are not going to recover despite whatever support you're giving them. And then you've got that huge valley in between that is the transitioning between the two.

Laura: Yeah

Angel: And that's what some of them aren't grasping is you've got this danger zone that if you're in it early enough you might be able to save them, but if you're at it too late. And I think that's why that whole concept...

Laura: Huh

Angel: ...with Cowley and the Golden hour whatever...

Laura: Okay

Angel: You know it although all of that has been proven false now.

Laura: Yeah

Angel: I think that intellectually the concept for our medical profession...

Laura: People need to understand it.

Angel: Yeah, our relatively uneducated medical profession, I think it helps them understand. I really do, I always have.

[01:49:47.26]

Laura: So what do you think about that person who had the there was a map where they had like it could go either way. Do you think that person really understood the decompensated stage?

Angel: They said decompensated could go either way?

Laura: I don't really remember...

Angel: No, we had the one that had compensated or uncompensated...

Laura: Yeah, yeah, yeah, yeah, no but

Angel: ...there are only two types.

Laura: Yeah, but there was the map it had weird blocks umm where they were saying for some of the things it was either way. Yeah this one. Like see how they said...

Angel: Uh huh

Laura: Do you think, how do you, so you think that person really...

Angel: I thin...

Laura: ...grapsing

Angel: Yes, I do because that's what you...

Laura: Number 4

Angel: Yeah because that's what, I didn't code everything in here.

Laura: Mmmhmm

Angel: With the ors, but the tendency is to have it go one direction or the other. But the thing about umm the heart rate is gonna be dependent on other medications. Beta blockers and things like that.

Laura: Mmmhmm

Angel: So if you could put the caveat that there's no medications influencing, there's no kind of you know cardiac devices that are influencing rate.

Laura: Mmmhmm

Angel: That a patient without those tends to go one direction or the other.

Laura: Mmmhmm

Angel: So and I think that some of them maybe get fixated because we do talk about and it says a lot in the book actually about if you've got a patient on beta blockers because you want to try, **we sort of want to drive the students away from thinking in terms of absolutes.**

Laura: Okay

Angel: But there are some trends that they need to recognize.

Laura: Okay

Angel: And I think that that's where they don't make the subtle difference is in recognizing a trend.

Laura: Mmmhmm

Angel: Because of the influence of the pharmacologic thing, like a beta blocker.

Laura: Okay

Angel: So like for example with my husband you know with his the fact that he's on umm beta blockers and he's also on a lot of different medications because of his cardiac history he won't express with tachycardia.

Laura: Mmmhmm

Angel: And he actually when he gets on the treadmill and he goes in for his cardiac studies in his annual examinations with his cardiologist, they actually have to induce tachycardia because he won't become tachycardic even though he could be exhausted on the treadmill from running, he'll get exhausted particularly since he hasn't been on the treadmill lately. He'll be exhausted in a matter of a minute or two but he won't get tachycardic.

Laura: Mmm

Angel: And they want him to be tachycardic so they can do the stress test.

Laura: Yeah

Angel: See if he gets rhythm changes.

Laura: Yeah

Angel: So they actually have to induce it with adenosine.

Laura: Wow

Angel: To make him tachycardic so that they can then see if there's any umm EKG changes.

Laura: Wow

Angel: Yeah, and that's what happens with a lot of those folks that have to have that, they have to do the pharmacologic studies because...

Laura: Mmmhmm

Angel: ...exercise won't induce them.

Laura: Okay

Angel: Now for me who's a big lumpy on the couch potato kind of person I get tachycardic just looking at a treadmill, you know. [laughter]

Laura: Yeah

Angel: You don't even turn it on and I get tachycardic so...

Laura: Hmm

Angel: ...it makes a difference. Alright so let's get back to this map.

Angel's Thinking About Novices
Shock
[02:14:00.10] Angel identifies a topic that needs more focus. She also talks about the students not critically thinking and applying the knowledge of shock to patients in class.

> Angel: Yeah we definitely need to talk more about pulse pressure. I think they're getting basics though. It's really hard to talk about...the vital signs because again you can simplify it and put them in absolutes but that's not the presentation they're going to get and that's why it's they really have to think through what the presentation is and kind of critically think...

> Laura: Uh huh

> Angel: ...and in some cases when you're in that decompensated zone you really, they really need to make not that it should affect their treatment, they should be aggressive. And that was one of the things I had to tell these guys because a couple of the umm priorities that they would give me is they would articulate with the scenario that the patient was in decompensated shock but then would assign them a priority of three. And it's like you guys aren't getting that everybody in shock really needs to be a one. They're not gonna die at this moment in time but they still need to be aggressively cared for. And so they were missing that whole and we talked about that one day that they were missing that whole you know cause it they're just so used to seeing these signs and symptoms that then they're not really applying it properly. So...

> Laura: Priority three? See I consider Priority three's like they belong in an urgent care clinic.

> Angel: Right, and but what was happening is they were rec... they were thinking because the patient was presenting in compensated that all of a sudden they were less urgent.

Training Segment: Black vs. White (Novice Way of Thinking)
Diabetes Analysis Part 2
[00:20:40.09]

> Angel: See this person is, really is talking in absolutes. You know what I mean?
> Laura: Yeah.
> Angel: Major risk, most common...
> Laura: Yeah, they're getting very specific.
> Angel: Yeah
> Laura: Umm, "diabetes increases risk of peripheral vascular disease."
> Angel: It's a truthful statement and we did not make that connection ourselves. We went through neuropathy to PVD.
> Laura: Huh
> Angel: It could, we talked, we actually talked about that when we built the map.
> Laura: Okay
> Angel: So it's not an untruthful statement, we just didn't think...
> Laura: Okay
> Angel: ...the students would jump there.
> Laura: Okay. So this get's a "B?"
> Angel: Yeah

Training Segment: Misconception
Shock
[01:22:11.26]

> Angel: Ooh this person has a problem. Interesting.
> Laura: Hmm
> Angel: And it's three.
> Laura: They got three?
> Angel: Uh huh
> Laura: Did you already tell me three or you just coded it?
> Angel: No
> Laura: Okay
> Angel: I just now did it. But look at what they did. So they have two types...
> Laura: Uh huh
> Angel: Shock uncompensated, this type of shock is irreversible.
> Laura: Huh
> Angel: So then they didn't talk about irreversible.
> Laura: Wow
> Angel: And that's wrong.
> Laura: Yeah
> Angel: And that's obviously something big we need to address with the students because that's a big fallacy in their thinking.

Laura: Wow

Angel: So...

Laura: They totally...

Angel: Yeah, so this is LL?

Laura: Yeah

Angel: LL

Laura: They think there's two types of shocks, not three.

Angel: Yeah, right so that's what I'm saying this person has a big flaw in their thinking.

Laura: Wow

Angel: It's okay, we'll fix it.

Laura: [laughter]

Angel: LL

Laura: Okay

Training Segment: Novice vs. Expert

2011 ANS Analysis Part 1

[00:28:11.16]

Angel: I like their use of, I mean I don't like it, but I like their use of 'has.'

Laura: Really?

Angel: Yeah

Laura: It's so general.

Angel: Yes.

Laura: It teaches you something about them.

Angel: Well because yeah this is a deep concept and they're superficial. But the thing is, it has, it has sympathomimetic and sympatholytic, so it's an incomplete statement too.

Laura: Mmmm, okay.

Angel: But, but it's okay because then that would be another branch.

Laura: Yeah, okay. I see what you're saying.

Training Segment: Novice vs. Expert

2011 ANS Analysis Part 1

[00:42:36.13]

Laura: So then...umm... "Adrenergic medications can also exhibit sympatholytic effects."

Angel: And "sympathomimetic effects" those are both correct.

Laura: Okay.

Angel: And...where is it now, "adrenergic...sympatholytic..." I think they took it one step beyond. I think they went one step beyond.

Laura: Really?!

Angel: It's just an odd, it's quirky, but okay. Here.

Laura: Huh.

Angel: It's similar to what they did. But they said "adrenergic..."

Laura: "Adrenergic medications can also exhibit sympatholytic effects."

Angel: Huh...It's not untrue.

Laura: [Laughter]

Angel: I just don't...

Laura: This stuff is complicated.

Angel: Well I just don't think of it in those terms. That's all. It's not an untrue statement...what they're...but why it's weird or quirky...is because those terms are synonymous. Adrenergic and sympathetic are synonymous. That's where the use of the statement is a little twisted.

Laura: But look what they went on to do. "Block and stimulate alpha and beta receptors."

Angel: Yeah and again alpha and beta wasn't in the...

Laura: So they were really using this as a study tool.

Angel: Right. Right. And it's actually much deeper than I intended to...when we constructed the map, we just did the nervous thing, so it's actually a lot deeper than where we meant to go. But what's interesting here though is...this statement here "adrenergic medication can also exhibit sympatholytic effect."

Laura: Mmmhmm

Angel: Would be like saying capital A is the same as lowercase a, I mean it's a, it's a, what type of a statement is that? The relationship...

Laura: Redundant.

Angel: Yes. Yes.

Laura: Mmmhmm.

Angel: It's redundant.

Laura: But it's...

Angel: Now this though is good, but this is...what they're saying is adrenergic effects, you know, that these are the effects... but this is very good that it's beyond the scope of what we were asking them to do."

Laura: Well, let's catalog them, cause they appear to all be student generated.

Angel: Okay.

Training Segment: Novice vs. Expert

Respiratory Meds Part 2

[01:35:15.28]

Angel: Very linear.

Laura: I wonder if the duplicate concepts like in that case that duplicate concept almost looks like they weren't like paying attention. Like it looks like it was done in, like that duplicate concept looks like haste you know whereas the other duplicate concept in the really complicated map that we saw that looked like the map was so complicated...

Angel: Right, they respoke...

Laura: ...that they didn't even realize.

Angel: well or they respoke it.

Laura: Yeah

Angel: It's like they first talked about bronchodilation.

Laura: Mmmhmm

Angel: And then they talked about receptors and they talked about targeting

of the receptors, so the natural endpoint to some of those receptor targets is bronchodilation so you could see how that would come out a couple times because of the layers.

Laura: Yeah

Angel: Yeah, but this one yeah it's very simplistic.

Laura: Mmmyeah

Angel: Everything, there was basically two levels here. Everything coming into bronchodilation they just had the classes.

Laura: Mmmhmm

Angel: And then they just gave you a couple examples of each of them, but this one they decided to talk about the bronchial smooth muscle relaxation. And this one just gave you the subclasses.

Laura: Mmmhmm

Angel: So and then this effects that receptor and it's a mineral. And I mean this is very much a one trick pony do it in five minutes.

Laura: Yeah

Angel: To turn it in for a grade map versus a conscious thinking of the relationships and you know...

Laura: Yeah

Angel: ...doing some depth analysis.

Included in Training as Helpful:

Novice Definition:

-Beginner Characteristics

-Difficulty w/ Comprehension

-Incorrect or Lacking

-Extraneous Unnecessary Information

-Outside the Norm

-More in Depth

Practice After Training
Laura Code: NE & M
Sabrina Code: NE & M
2011 ANS Analysis Part 1
[00:18:52.09]

      Laura: And then we have a sympathetic nervous system purpose is fight or flight.

      Angel: We didn't speak it like that. We spoke it in terms of a memory tool.

      Laura: Oh, so that actually is different. That is a unique idea.

      Angel: Yeah. The purpose is...

      Laura: Cause that's not exactly the purpose of it.

      Angel: Right

      Laura: Like it has many purposes.

      Angel: Well. But it's one thing that it does.

      Laura: It's, it's one purpose. It's not the only purpose. So it's...

      Angel: Huge spelling. Lots of spelling errors by this person.

      Laura: Oh, oh that is interesting. Umm...so would you consider that kind of like a misconception about it?

      Angel: Umm...

      Laura: Or I mean it's partially true, but it's...

      Angel: It's overly simplified. I don't think it's incorrect.

      Laura: So you would call it an oversimplification. So let's write this down as student generated.

      Angel: Okay

      Laura: We'll give it a letter. So we'll give this an A and we'll call it, we won't call that correct or incorrect. We'll call that an overgeneralization. Which is a type of misconception, by the way.

      Angel: Okay

      Laura: In the misconception literature.

Practice After Training
Laura Code: NE
Sabrina Code: NE
2011 ANS Analysis Part 1
[01:02:58.01]

      Angel: What scares me though is this...

      Laura: Why?

      Angel: That's a beta-blocker. Why is it even on there? Oh my goodness. They're correct. "Neurotransmitters like labetalol exhibit sympatholytic effects." Cause it does block...labetalol is a beta-blocker...

Laura: But is it a neurotransmitter?

Angel: It's a drug.

Laura: But it's not a neurotransmitter.

Angel: I'm not aware of it being a neurotransmitter.

Laura: It's not natural, right?

Angel: Umm...

Laura: Or...

Angel: I don't think so...it's a medication.

Laura: Yeah

Angel: It's given to patients. And it is antiadrenergic. But again this is, this whole thing is, this whole thing is irrelevant, is another sidebar.

Laura: Mmm.

Angel: And...

Laura: Maybe they were...

Angel: This...

Laura: ...searching for something there.

Angel: Well this is a sidebar, but it is one that they will be required to learn. And obviously...[unintelligible]

Laura: Well maybe they were just searching for an actual balance. Is what it looks like. Maybe they figured there should be some natural balance. Like is there a natural beta blocker? I mean that the...that doesn't make any sense though. [laughter] That's interesting. Hmm.

Angel: You're nat...as far as I know the natural occurring beta, any beta blocking that's coming is through your renin and angiotensin and aldosterone and your fluid shifting, its not true beta blocking. But it's happening through the fluid shifting that's regulating your vascular sy...

Laura: So maybe they were just upset because

Angel: Well...

Laura: They had this nice organized chart and there was just this chunk missing and they were, they couldn't make sense out of it in their head, and they thought it needed these like symmetrical so they went researching.

Angel: Yeah, could be, could be

Laura: That's kind of what it looks like to me.

Angel: To balance it out.

Laura: Yeah, that's interesting.

Angel: I don't know that we're going to encounter it with anybody else.

Laura: I don't think we are going to, so I would say we just circle this whole thing. Okay.

Angel: This was beyond the scope of the presentation.

Laura: And I don't think we're going to encounter this with anybody else either.

Angel: Right we didn't, we haven't done medications other than epi, norepi. And I, you know I talk to them about atropine on a very superficial

level just to give them an illustration of something that has parasympatholytic effects, but it was just very superficial.

Laura: Okay.

Practice After Training
Laura Code: NE
Sabrina Code: NE
2011 ANS Analysis Part 1
[02:35:28.15]

Angel: Wow! So much about feeding and breeding here!

Laura: [laughter] People's favorite activities.

Angel: Well and it was, but it was slang. That's what's so strange about it. It's just a slangy... You know but it shows you the power of mnemonics, I guess. See we had it as a memory tool: fight or flight.

Laura: Yeah.

Angel: But not causes, fight or flight stimulates parasympathomimetic or sympathomimetic but not sympathetic. We don't have that statement as you're saying it. We have the purpose as an overgeneralization. We have controls. I think, does that sound pretty good? SNS controls fight or flight? Causes? What do you think?

Laura: No cause it's "parasympathomimetic causes feed or breed."

Angel: Right and then "sympathetic causes fight or flight," right?

Laura: No, "sympathomimetic causes fight or flight." And then we have "fight or flight is the result of sympathetic." So we do have that: "fight or flight is the result of sympathetic."

Angel: Okay, SNS controls fight or flight, that's "S".

Laura: Okay and then...

Angel: PNS controls feed or breed, that's "V".

Laura: Okay

Angel: Okay, now what else?

Practice After Training
Laura Code: NE
Sabrina Code: NE
2011 ANS Analysis Part 2
[00:00:00.00]

Angel: ...which is an expert from a novice. Is that novices or experts lose the ability to think like a novice.

Laura: Yeah.

Angel: I've actually heard that, you know, quite a bit. And you know this is obviously a novice pattern of thinking.

Laura: Yeah.

Angel: And if, and I look at it and you even look at it and although this is, this is, you're connecting this to other knowledge you already have you're looking at this going it doesn't make sense.

Laura: Yeah.

Angel: And I'm looking at it going it doesn't make sense. But obviously to them it made perfect sense or they wouldn't have coded it and put it on paper. And that's to them, that's a logical relationship.

Laura: Maybe. Or there's the possibility that they didn't quite understand it and they drew it anyways. [00:01:03.07]

Angel: [00:01:03.20] Right.

Laura: Umm, okay so today is nine twentyeight and we're still coding the autonomic nervous system maps. And we forgot to put on the recorder to talk about umm we were discuss...

Laura Code: Laura Misconception was original code. Agrees with Sabrina except Angel Novice / Expert due to saying irrelevant.

Sabrina Code: Laura Misconception; Angel majority Misconception with minority Novice /Expert due to saying incorrect.

2011 ANS Analysis Part 2

[00:04:15.13]

Laura: So this is just one giant misconception.

Angel: It is. "Neurotransmitters, there's two types: adrenergic and cholinergic," is not a true statement. There are adrenergic and cholinergic receptors.

Laura: Okay, so we know this is wrong and these are student generated statements.

Angel: Yes

Laura: We can create letters for these.

Angel: Right

Laura: Cause we don't, we haven't seen this yet, right?

Angel: Right, not that I remember.

Laura: I don't remember seeing this. Cause even if they're referring to the receptors or not this is just wrong.

Angel: Yes it's very wrong. And they are not looking at the incorrect statements, they're not a whole lot of those actually. Sympathomimetic effects...

Laura: I think all of these were that one map, right?

Angel: Sympatholytic effects...yeah.

Laura: That had them backwards.

Angel: ACH, yeah, ACH releases cholinergic norepi. Adrenergic...so they're not specifically pointing back to receptor...neurotransmitters. So we can make them new. Yup, they're new.

Laura: Alright.

Angel: "RR" so what's the first one?

Laura: Umm, "neurotransmitters two types adrenergic," so I guess we could say "neurotransmitter one type adrenergic."

Angel: Mmmhmm. That is incorrect. And there is one of those.

Laura: And neurotransmitter one type cholinergic.

Angel: And that's "SS." Okay.

Laura: Alright, so. And you want to put a little note there like maybe in

parentheses that they might have been referring to these as receptors. Like do you just want to make a note, err?

Angel: Even if they mean this as a receptor it's still an irrelevant statement.

Laura: Wrong, yeah. Do we want to notate it though, like?

Angel: Well sure, you can do that.

Laura: I mean, just put it in parenthesis or something like...the whole thing is just curious to me. So maybe that's something to note is that in the future maybe this master map should have the receptors on it cause clearly they seem to want the receptors to be on there.

Angel: And I deliberately didn't do that because it was so much.

Laura: Yeah

Angel: ...because we didn't have nicotinic, muscarinic, alpha, beta. We just didn't...

Laura: But they seemed, at least they seemed to wanted to have at least the adrenergic...

Angel: And I prevented that information...

Laura: ...they seemed to have wanted to include that.

Angel: Yeah connected.

Laura: Yeah.

Angel: Interesting.

Laura: Umm.

Angel: Okay.

Laura Code: NE
Sabrina Code: NE
2011 ANS Analysis Part 2
[01:01:05.16]

Angel: Cause then that will kind of tell me and my thinking, cause I do often wonder about and I've been, I've been at a couple different meetings and things where that whole concept of we cease to be able to think like a novice.

Laura: Yeah.

Angel: And so I've kinda sorta refocused on that the last couple of years. Like how do they think about these concepts. And why is it so...

Laura: A struggle.

Angel: Well why is it something that is so blatantly obvious to us is such a big struggle for them, and I think if, I think one of the keys in helping, I don't know.

Laura Code: NE
Sabrina Code: NE
Diabetes Analysis Part 2
[00:07:05.26]

Angel: When I was speaking yesterday about your project in the division meeting. I'll put it on the tape for you now, but umm, yesterday at school, umm we were doing a celebration of the end of the semester.

And umm our department chair asked us to each speak about our learning outcome projects and our teaching improvement projects and that's part of our requirement as faculty members we each have to be working on an approved teaching improvement or learning outcome every year.

Laura: Uh huh

Angel: And they don't have to be huge, they just have to be something that's showing that we're analyzing what we're doing and improving.

Laura: Okay

Angel: And so me talking about our project which is a formal research, you're working on your dissertation. Obviously its a big deal.

Laura: Okay.

Angel: I mean it was a big, big deal.

Laura: Okay

Angel: Umm, but I was talking with the faculty members one of the things that I mentioned to them that this process has done for me is I said you know any of us that have been teaching for ten years or fifteen years or twenty years sometimes the students and maybe even other educators will tell us that we've lost the ability to think like a novice and to recognize what a novice is going through...

Laura: Mmmhmm

Angel: ...because we're content experts now and we've mastered it and so we sort of forget those struggles that we go through. But I said one thing that this project has done to help me with is going back and analyzing the students' this allows me to analyze the students' thought processes in a way I haven't been able to do before. And it really gives me a lot of insight because sometimes when they answer test questions and I walk away from that I think why did they pick that answer, that's ridiculous, you know.

Laura: Yeah

Angel: There's no way that answer is the correct answer, but then when I see their thinking processes illustrated here in the way they've shown me how they've made the connections, I can go back and go oh, now I, even though it's still flawed and wrong.

Laura: Yeah.

Angel: I can actually sort of see the path...

Laura: Uh huh

Angel: ...that they took to get to that wrong answer a little bit clearer. And it kind of helps me realize that I make assumptions that there con...making connections of logic that they're really not.

Laura: Mmm hmm

Angel: And so this has really helped, this you know analyzing that previous map and I'm sure with this one too it'll help me see how these are really complicated processes and its not an easy thing for them to get this the first pass. And that we need to keep trying to create ways that they can continue to manipulate this.

Laura Code: BW
Sabrina Code: NE
Diabetes Analysis Part 2
[00:45:47.07]

Laura: Alright

Angel: So we needed to make a connection down here to PVD and a connection over to hypertension.

Laura: Yeah. There's a couple of extra connections and I think we didn't make them because...

Angel: ...on purpose...

Laura: ...on purpose because we were focusing on diabetes...

Angel: Right

Laura: ...not those other things.

Angel: Right but it's in...it's good, it's actually good the students...

Laura: ...are making these...

Angel: ...were are making them, yeah.

Laura: ...because its showing that they know these things but its interesting because they're not, they're making them in a sense because they know less about diabetes, if you think about it. Like we're seeing...

Angel: They're just flinging poo.

Laura: Well they're not flinging poo, it's showing what they know but its showing that they don't know as much about diabetes as you wanted, but its showing what they did actually learn throughout the class.

Angel: Well but I'm trying to think about had we taught hypertension and PVD yet and I guess we did because we'd had done cardiac [unintelligible]

Laura: Yeah cause you'd already done cardiac.

Angel: ...so they hadn't had that.

Laura: Yeah

Angel: [Unintelligible] That instruction had occurred for those two diseases.

Laura: [Unintelligible]

Angel: So they're making the connection backward is what you're saying, but they're not making the connection forward.

Laura: Well they're just, they're not focusing on the topic at hand which is diabetes like what this is showing you is that they're depth of knowledge about diabetes is not as deep as you wanted it...

Angel: Mmmhmm

Laura: ...but their breadth of knowledge about in general is fairly good but its surface level.

Angel: Right

Laura: Like a lot of these things that they're making are very surface level things.

Angel: Right

Laura: That you weren't looking for, you wanted them to really show I know diabetes really well and they're not showing that. They're showing

262

you know a decent number of misconceptions about diabetes and I mean admittedly some of those things that they're showing about diabetes are kind of like duh things that you took for granted.

Angel: Well they're sort of....

Laura: And didn't even put on the map.

Angel: ...the pop psychology, pop science, the mythy how EMS you know talk, wants to teach absolutes and wants to put everything in a nice little box for everybody and say well this is the number one cause. Well really is it, how do you know that? You know what statistics are you using to drive that? Where is that information coming from? Is it because your instructor told you that?

Laura: Yeah

Angel: When you were in EMT school.

Laura: Yeah

Angel: Is it because of your own belief, is it because of what you've seen in the media...

Laura: Yeah

Angel: ...that's led you to make this conclusion? I mean what is that conclusion based on cause its definitely not based on the instructional process that you received from us. So, yeah.

Laura: That's interesting. Okay.

Laura Code: Original was Novice / Expert; Agree with Sabrina that Laura was Misconception.
Sabrina Code: Angel NE; Laura M
Diabetes Analysis Part 2
[00:50:29.09]

Laura: "Blood glucose exceeding the normal limits will cause diabetes."

Angel: High blood glucose levels lead to diabetes. Superficial. It is very superficial. The high blood glucose level doesn't cause diabetes.

Laura: No, so the cause in there makes it incorrect.

Angel: That's what I'm saying, it's...

Laura: Yeah

Angel: It's a naive statement.

Laura: Yeah, if you interpret it totally correctly they are totally literally the cause makes it incorrect.

Angel: Right

Laura: That cause in there makes it incorrect.

Angel: They are not seeing cause and effect and they are not seeing that in several of their statements.

Laura: So you want to make this an "M?"

Angel: And it's an incorrect statement.

Laura: Okay, umm.

Laura Code: BW
Sabrina Code: NE
Diabetes Analysis Part 2
[01:02:11.14]
>Angel: You oughta have another con... thing here for umm instead of making it a fifty-fifty you oughta have a code here that's you know going the right direction but not quite type of a code. You know what I mean?
>Laura: Ohh
>Angel: Like they're on track but they're just not there yet.
>Laura: [laughter] Huh. Like a...
>Angel: Mostly correct, or partially correct.
>Laura: Like maybe a number scale, like a Likert scale instead of correct versus incorrect, like a Likert scale in terms of how correct.
>Angel: Well ya one is correct, well one is correct, er one is incorrect, three is incorrect and two is on that continuum in the middle.
>Laura: Okay, hmm.
>Angel: Because somebody like that statement is partially correct, but it's also incorrect because its not detailed enough. But I wouldn't go crazy with it and then you're sitting there trying to figure out degrees. But if there's some element of correctness but not quite, because several of these incorrect ones they're in the ballpark but its just, its just not firm enough, yet.
>Laura: Hmm
>Angel: You know what I mean?
>Laura: That's a good idea. Umm.

Laura Code: NE
Sabrina Code: NE
Respiratory Meds Part 2
[00:15:18.29]
>Angel: Okay, this is a nonsense. "Bronchial smooth muscles causes bronchodilator." These this, all of these terms refer to the class of drugs, so bronchodilator is correct. This is a nonsense statement. So is that just "I" and its wrong?
>Laura: Uhh, I think...I think they're in a very maybe perhaps they're saying in a very roundabout way that relaxation of the...
>Angel: They already did that.
>Laura: ...bronchial smooth muscles causes bronchodilation. [Unintelligible]
>Angel: Well here the term is a drug.
>Laura: Yeah
>Angel: Bronchodilators cause bronchial smooth muscle what?
>Laura: If you think it doesn't make any sense, yeah, I see what you're saying how they already said it relaxes it.
>Angel: Yeah they already talked about that stuff, so I think that's just a nonsense so and the direction of the arrow its "bronchial smooth muscles causes bronchodilator" and that's a nonsense statement.

Laura: Maybe if you read the whole thing together, "beta-2 agonist relaxes bronchial smooth muscles causes bronchodilator."

Angel: But they meant bronchodilation. I'm sure.

Laura: Yeah

Angel: But they're talking about the drug class there.

Laura: Yeah

Angel: So then that makes all the rest of these wrong if you read that as...

Laura: Yeah

Angel: And a lot of these are right.

Laura: Yeah

Angel: So I think they just made a stupid connection.

Laura: Okay

Angel: So bronchial smooth muscles so that's an "I"

Laura: Mmmhmm

Angel: Bronchial smooth muscles causes and underline causes bronchodilator and that's incorrect. And it'll probably only show up once, but...

Laura Code: NE
Sabrina Code: NE
Respiratory Meds Part 2
[00:19:54.19]

Angel: So they phrased things oddly. And they kind of went different directions from me and the thought processes but they had a lot of correct things to say.

Laura: Okay

Angel: And this is map one.

Laura: Okay.

Laura Code: NE
Sabrina Code: NE
Respiratory Meds Part 2
[00:50:39.17]

Angel: "Beta-2 agonist if it binds to multiple sites is non-specific beta-agonist." It's that's a non-sense statement. Beta-2s are specific, non-specific betas are not beta-2s, so...

Laura: I think they're saying there that a beta, a non-specific beta agonist is...oh yeah that doesn't make any sense.

Angel: Unless they're trying to say that...

Laura: ...that it's related to a beta-2...

Angel: ...if it's, it's either, I don't know if they're saying it's an either or statement...

Laura: Maybe

[microwave popcorn & strawberry interlude]
[00:54:53.25]

Angel: "Beta-2 agonist non-specific if it binds to multiple sites its called non-

specific," but beta-2 agonists are not non-specific. So that's why this is difficult. Beta-2 agonists bind to beta-2 sites.

Laura: Mmmhmm

Angel: Non-specific beta agonists could have cardiac or respiratory cause they could be beta-1 or beta-2 binding.

Laura: Yeah

Angel: So is it an "AA?"

Laura: I don't, I mean sure.

Angel: Okay. And it's incorrect. It's partially correct, it's close, but it's not. Had they made it two statements they probably would have had it right.

Laura: So it's beta-2 agonist...

Angel: Mmmhmm

Laura: And then where do you want the middle to be?

Angel: If it binds to multiple sites...and that should be underlined. Non-specific beta agonist.

Laura Code: NE
Sabrina Code: NE
Respiratory Meds Part 2
[01:25:54.28]

Angel: This person did a pretty good job, they just spoke at it differently than we would. But they spoke a lot of truths. You know what I mean?

Laura: Yeah

Laura Code: Laura M
Sabrina Code: Laura M; Angel BW
Shock
[00:32:20.15]

Angel: This is a false statement. "Compensated is adequate perfusion."

Laura: So M?

Angel: Yeah...it's similar to nine but, they're saying adequate and it's really not, it's compensating, I mean that's why it's compensated. It's umm you know what I mean. It's not really adequate perfusion. It's just bringing it back to baseline but there's still some...there's still a problem.

Laura: Well that student's demonstrating a misconception.

Angel: Yes, yes they seem to believe that when you're in compensated shock you're okay...is what that implies to me. It's adequate.

Laura: Yeah

Angel: And it's not, it's a return to baseline of that insult, whatever it may be. It's a temporizing measure. And they're not seeing that.

Laura: Okay, so it's a subtle wording difference that you're picking up on...

Angel: Well, particularly with some of the other statements.

Laura: They're not demonstrating that it's a problem.

Angel: Well, right. Because with some of the other statements they've made they are hitting absolutes and extremes.

Laura: Okay

Angel: That leads to organ failure, that equals for that, that equals that. So they are seeing a progression, but in this case, this seems, they're claiming that it's normal.

Laura: Mmmhmm

Angel: And that's not true.

Laura: Okay

Angel: Alright

Laura Code: NE
Sabrina Code: NE
Shock
[01:35:08.10]

Laura: So how do you want to word it?

Angel: I don't know. Low blood pressure is...equals shock, I guess. I mean that's how I'm reading this. Shock BP lowers blood pressure. Blood pressure lowers shock. Shock lower...they're saying that...am I reading too much into it?

Laura: I think that they're trying to say that like low blood pressure...

Angel: ...equals shock.

Laura: ...equals shock.

Angel: Yeah and that's what I'm seeing there too. That's fine. That's what I'm seeing.

Laura: So you don't want to code that though as umm...low BP is a late sign of shock?

Angel: No, cause it's that quantifies it more than what I think...

Laura: Okay

Angel: ...this student did. They're making it a broader statement. I think that one's more narrowed.

Laura: Okay, okay.

Angel: See I don't even know what the connection is here. Cause it...man this is really jumbl..., it's really not...I'm gonna run to the restroom...

Laura: [laughter]

Angel: ...think on it. You can think on it while I'm gone...

Laura: Okay

Angel: ...cause it's very jumbled thinking. And it's kind of all over the place. [01:37:02.11]

[bathroom break]

[01:39:48.12]

Laura: This is rough. I kind of...

Angel: [unintelligible] stuff, isn't it?

Laura: I kind of see a thought process here but it's hard... They're umm they're trying to like...

Angel: ...make connections...

Laura: ...go down and up on both sides.

Angel: Yeah

Laura: A little bit, they're trying, like there is some work in here.
Angel: Uh huh
Laura: It's just...I think they really struggled. Or didn't put a much time and ener..., I mean when I see things like this...
Angel: Yeah, I don't like to...
Laura: I'm pained.
Angel: Well I don't like to assume that they didn't put any effort into it cause we don't know
Laura: Well, honestly when I read the surveys on average they all spent less than a half hour on these.
Angel: Oh, so okay they're not.
Laura: Which is very inappropriate for a concept map of this complexity.
Angel: Right
Laura: I want to be seeing an hour at a minimum. Cause think about how long it took us...
Angel: Well remember these are the same...
Laura: ...to build these.
Angel: Well, agreed, these are the same students who go through a seventy question multiple choice test with four answer choices fifty words roughly each question in twelve minutes. Yeah, so...
Laura: Umm why don't you look at that for a few minutes.
Angel: You're gonna go to the bathroom, now.
Laura: Yeah, I've gotta go [laughter]
Angel: Okay

Laura Code: Instructor Map Missing Proposition
Sabrina Code: Doesn't make sense, not like the others
Shock
[01:46:47.20]
Angel: That's okay. Yeah, next time I added this.
Laura: Oh cool
Angel: And then we'll have to put a number in for it.
Laura: [unintelligible] shock
Angel: ...is low blood pressure.
Laura: equals blood pressure, okay.
Angel: And organ failure leads to death. We've seen that a couple times too but...
Laura: Okay
Angel: And then there's the equations
Laura: Okay
Angel: So it's the output, heart rate stroke volume equals output. Heart rate stroke volume vascular resistance equals blood pressure output times vascular resistance, I taught them all three.
Laura: So how you put two blood pressure equations and the cardiac output equation.
Angel: Yeah we've got two. Two ways of expressing it.

Laura: Alright. Okay.

Angel: So

Laura: Cool, awesome.

Angel: Yeah and I'm not sure because again with that being like that I'm not sure how you add that in without doubling up on the words which you don't want to do and I think that maybe that's why we didn't put them in.

Laura: I don't necessarily think we need to add them in, I think its a neat phenomena that they added them in.

Angel: Uh okay.

Laura: That's what I thought...

Angel: So maybe we put that as part of the key or something for the next time. But this is something I'm seeing that I want to reinforce with each of them, more physiology.

Laura: Okay

Laura Code: BW

Sabrina Code: NE, not BW because Angel is talking about patients, not student thinking

Shock

[01:48:06.00]

Angel: Which I think is actually cool they're getting it but some of them aren't quite getting it all.

Laura: Okay

Angel: For example the one who didn't make the connection that there's three types.

Laura: Okay

Angel: So that'll be something to emphasize. And I kind of like to do that with some scenario things.

Laura: Mmm

Angel: Like here's some vital signs and make them vague...

Laura: Okay

Angel: ...in some cases, make them obvious in others. But make some of them vague so they actually have to declare what they think it is.

Laura: Okay

Angel: You know cause the patient's aren't always completely black and white, it's those shades of gray. And I think that that'll help drive home the idea that decompensation is the transitional stage.

Laura: Yeah

Angel: And you've got the compensated who can fairly easily recover with the right support.

Laura: Yeah

Angel: And then you've got the irreversible, which are not going to recover despite whatever support you're giving them. And then you've got that huge valley in between that is the transitioning between the two.

Laura: Yeah

Angel: And that's what some of them aren't grasping is you've got this danger

269

zone that if you're in it early enough you might be able to save them, but if you're at it too late. And I think that's why that whole concept...

Laura: Huh

Angel: ...with Cowley and the Golden hour whatever...

Laura: Okay

Angel: You know it although all of that has been proven false now.

Laura: Yeah

Angel: I think that intellectually the concept for our medical profession...

Laura: People need to understand it.

Angel: Yeah, our relatively uneducated medical profession, I think it helps them understand. I really do, I always have. (SPLIT)

Laura Code: BW
Sabrina Code: BW
Shock
[01:49:47.26]

Laura: So what do you think about that person who had the there was a map where they had like it could go either way. Do you think that person really understood the decompensated stage?

Angel: They said decompensated could go either way?

Laura: I don't really remember...

Angel: No, we had the one that had compensated or uncompensated...

Laura: Yeah, yeah, yeah, yeah, no but

Angel: ...there are only two types.

Laura: Yeah, but there was the map it had weird blocks umm where they were saying for some of the things it was either way. Yeah this one. Like see how they said...

Angel: Uh huh

Laura: Do you think, how do you, so you think that person really...

Angel: I thin...

Laura: ...grapsing

Angel: Yes, I do because that's what you...

Laura: Number 4

Angel: Yeah because that's what, I didn't code everything in here.

Laura: Mmmhmm

Angel: With the ors, but the tendency is to have it go one direction or the other. But the thing about umm the heart rate is gonna be dependent on other medications. Beta blockers and things like that.

Laura: Mmmhmm

Angel: So if you could put the caveat that there's no medications influencing, there's no kind of you know cardiac devices that are influencing rate.

Laura: Mmmhmm

Angel: That a patient without those tends to go one direction or the other.

Laura: Mmmhmm

Angel: So and I think that some of them maybe get fixated because we do talk about and it says a lot in the book actually about if you've got a patient

on beta blockers because you want to try, we sort of want to drive the students away from thinking in terms of absolutes.

Laura: Okay

Angel: But there are some trends that they need to recognize.

Laura: Okay

Angel: And I think that that's where they don't make the subtle difference is in recognizing a trend.

Laura: Mmmhmm

Angel: Because of the influence of the pharmacologic thing, like a beta blocker.

Laura: Okay

Angel: So like for example with my husband you know with his the fact that he's on umm beta blockers and he's also on a lot of different medications because of his cardiac history he won't express with tachycardia.

Laura: Mmmhmm

Angel: And he actually when he gets on the treadmill and he goes in for his cardiac studies in his annual examinations with his cardiologist, they actually have to induce tachycardia because he won't become tachycardic even though he could be exhausted on the treadmill from running, he'll get exhausted particularly since he hasn't been on the treadmill lately. He'll be exhausted in a matter of a minute or two but he won't get tachycardic.

Laura: Mmm

Angel: And they want him to be tachycardic so they can do the stress test.

Laura: Yeah

Angel: See if he gets rhythm changes.

Laura: Yeah

Angel: So they actually have to induce it with adenosine.

Laura: Wow

Angel: To make him tachycardic so that they can then see if there's any umm EKG changes.

Laura: Wow

Angel: Yeah, and that's what happens with a lot of those folks that have to have that, they have to do the pharmacologic studies because...

Laura: Mmmhmm

Angel: ...exercise won't induce them.

Laura: Okay

Angel: Now for me who's a big lumpy on the couch potato kind of person I get tachycardic just looking at a treadmill, you know. [laughter]

Laura: Yeah

Angel: You don't even turn it on and I get tachycardic so...

Laura: Hmm

Angel: ...it makes a difference. Alright so let's get back to this map.

Glossary

Alternative Conception - student generated propositions that appear at a high

enough threshold for depiction on the composite map; propositions that do not

appear on the instructor's expected map.

Black Dominated Composite Map - a composite map dominated by black text

propositions indicating that the teacher's expected concept map is fairly

similar to the students' concept maps.

Black Text - instructor expected propositions that appeared on at least half of the

students' maps.

BLUE / CAPITAL Text - correct student generated propositions appearing on at

least one-quarter of the students' maps.

Chain Structure – a concept map in which all of the concepts are linked in a chain of

linear causality (Kinchin et al., 2000).

CMap Tools – a free, online, collaborative concept mapping software by Institute

for Human and Machine Cognition (http://cmap.ihmc.us/).

Composite Map - the product of the SMART analysis which depicts both visually

and quantitatively, the similarities and differences between the instructor's

expected concept map and the students' concept maps.

Concept - an abstract idea, event, or concrete object

Concept Map - graphic organizers that help students depict the relationships between

concepts. Each concept in the map is defined by the pattern of concepts to

which it is connected.

Criterion / Structural Scoring – a concept map scoring method that awards points

for the presence of different features within the map

Criterion-Referenced Assessments – assessments that provide information upon which action can be taken (Harlen & James, 1997), e.g. SMART Method.

Cross-links - propositions between concepts in different branches or sections of the map (Novak & Gowin, 1984 & Novak, 2010).

Cyclical Concept Map - concept map in which each concept has at least two propositions connecting it to the other concepts on the map, so that there are no "dead-end" concepts on the map.

Dynamic Propositions - propositions that describe "how the change in one concept affects the other concept" (Safayeni et al., 2005, p. 750).

Emergency Medical Responder (EMR) / First Responder - the lowest level of EMS training; the minimum level of EMS training required of all police and firefighters; considered a basic life support provider.

Emergency Medical Services (EMS) - organizations that provide medical care to patients outside of hospitals and traditional healthcare settings traditionally on an emergency basis.

Emergency Medical Technician (EMT) – the minimum level of EMS training required to staff an ambulance; considered a basic life support provider.

Focus Question – specific guiding question around which a concept map is constructed.

Formative Assessment - "encompassing all those activities undertaken by teachers

and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (Black & Wiliam, 1998, p. 7-8)

GREEN / ITALICS CAPITAL **Text** - incorrect student generated propositions appearing on at least one-quarter of the students' maps.

Hierarchical Structure – a concept map organized such that broader, more general concepts appear at the top of the concept map and more specific concepts are positioned at the bottom of the map (Novak & Gowin, 1984 & Novak, 2010).

Holistic Scoring Method – a concept map scoring method that involves assigning the map a score on a 1 to 10 scale based upon the scorer's judgment that the map represents the "mapper's overall understanding of the concepts represented by the map" (McClure et al., 1999, p. 483).

Hybrid Cyclical Concept Map – a cyclical concept map containing both static and dynamic propositions.

Instructor Expected Propositions - propositions that represent those ideas that were salient to the teacher based upon learning objectives.

Knowledge Space Theory - a mathematical theory stipulating that at any point in time, a concept is either present or absent (Falmagne & Doignon, 1988).

Net Structure – a concept map with a complex structure in which the concepts are related in a net of complex relationships depicting appropriate hierarchy (Kinchin et al., 2000).

Non-Directional Proposition – a proposition that has a linking line between the

concepts without an arrowhead to indicate directionality; the proposition can theoretically be "read" beginning at either concept.

Non-Novakian Concept Maps - do not follow as strict a set of rules for construction as Novakian Concept Maps; not restricted to a hierarchical structure.

Norm-Referenced Assessments - assessments capable of identifying problematic areas, without offering any suggestions on how or where to proceed (Harlen & James, 1997).

Novakian Concept Maps - constructed by strictly adhering to the steps outlined by Novak (1984, 2010); conform to a hierarchical structure.

Paramedic – the highest level of EMS training, equivalent to an associate's degree; considered an advanced life support provider.

Problematic Concept – a concept in which a majority of the propositions connected to the concept on the composite map are highlighted in **red** and/or *GREEN* text.

Proposition – two concepts connected together by a descriptive line

Propositional / Relational Scoring – a concept map scoring method in which each proposition is scored on a zero to three scale based upon the degree of specificity with which the mapper has clarified the relationship between the concepts (McClure & Bell, 1990 and McClure et. al., 1999).

Qualitative Structure Analysis – a method of analyzing concept maps in which they are categorized as having a structure resembling a spoke, chain, or net (Kinchin et al., 2000).

Qualitatively Similar Proposition - a proposition that depicts the same idea, using

different words.

Red and Blue Dominated Composite Map - a composite map dominated by red and blue text propositions indicating divergence from the instructor's expected map and convergence of the students' upon correct student generated ideas.

Red / Bold Text - instructor expected propositions appearing on less than half of the students' maps.

Red Dominated Composite Map - a composite map dominated by red text propositions indicating that the teacher's expected concept map is different from the students' concept maps.

Salient - the most important, obvious, or relevant ideas to the topic in the given context at a specific moment in time; can be viewed from a student's or instructor's perspective; the composite map also highlights salient ideas

SMART Method – an acronym for the Salient Map Analysis for Research and Teaching method of analyzing concept maps

Spoke Structure – a concept map with a simple structure in which all of the concepts are directly connected to a main concept (Kinchin et al., 2000).

Static Propositions - propositions that "describe, define, and organize knowledge" (Safayeni et al., 2005, p. 749).

Student Generated Propositions - propositions that represent those ideas that were salient to the student, but not the instructor.

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